Chapter 3
Affected Environment

In Chapter 3, the affected environment descriptions are presented to provide the context for understanding the environmental consequences described in Chapter 4. As such, they serve as a baseline from which any environmental changes that may be brought about by implementing the proposed action and alternatives can be identified and evaluated; the baseline conditions are the currently existing conditions. The affected environments at each site are described for the following impact areas: land resources, noise, air quality, water resources, geology and soils, ecological resources, cultural and paleontological resources, socioeconomics, existing human health risk, environmental justice, waste management, and spent nuclear fuel.

3.1 Approach to Defining the Affected Environment

For this *Draft Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* (*Nuclear Infrastructure Programmatic Environmental Impact Statement* [NI PEIS]), the candidate sites for neptunium-237 storage, target fabrication, and irradiated target processing facilities to recover plutonium-238 are the Oak Ridge Reservation (ORR), the Idaho National Engineering and Environmental Laboratory (INEEL), and the Hanford Site (Hanford). As described in Chapter 2, the candidate facilities for neptunium-237 storage, target fabrication, and irradiated target processing are the Radiochemical Engineering Development Center (REDC) at ORR, Building 651 and the Fluorinel Dissolution Process Facility (FDPF) at INEEL, and the Fuels and Materials Examination Facility (FMEF) at Hanford. The facilities being considered for irradiation of the neptunium-237 targets are the High Flux Isotope Reactor (HFIR) at ORR, the Advanced Test Reactor (ATR) at INEEL, the Fast Flux Test Facility (FFTF) at Hanford, a generic commercial light water reactor (CLWR), and one or two new accelerators or a nuclear research reactor that would be located at an unspecified existing U.S. Department of Energy (DOE) site.

As described in Chapter 2, the candidate sites for target fabrication and irradiated target processing facilities for industrial and medical isotope production and for research and development are Hanford, and the unspecified DOE site, where one or two new accelerators or a research reactor would be located. The candidate facilities for these target fabrication and irradiated target processing activities would be FMEF in the Hanford 400 Area, other existing processing facilities in the Hanford 300 Area, and a new processing facility located at an existing DOE site where one or two new accelerators or research reactor would be constructed. The sites being considered for research and development irradiation activities and for irradiation of targets for the production of industrial and medical isotopes are Hanford, where FFTF is located, and an unspecified existing DOE site where one or two new accelerators or research reactor would be located.

The affected environment is described for the candidate sites for the following resource areas: land use, visual resources, noise, air quality, water resources, geology and soils, ecological resources, cultural and paleontological resources, socioeconomics, existing human health risk, environmental justice, waste management, and spent nuclear fuel management. No additional spent nuclear fuel would be generated by the operation of HFIR, ATR, or a generic CLWR for neptunium-237 target irradiation; as they would be operating, even if they were not irradiating targets discussed in this NI PEIS. Additional spent nuclear fuel would be generated by the operation of FFTF or a new reactor located on an existing DOE site. Operation of the existing HFIR, ATR, or generic CLWR would continue to generate spent fuel, which is managed under current planning. New spent nuclear fuel would be generated by the restart of FFTF or a new research reactor located on an existing DOE site. Accordingly, spent nuclear fuel management is addressed in this chapter only in the sections for Hanford and an existing DOE site where a new research reactor would be located.

DOE evaluated the environmental impacts of certain research and development activities, and of industrial isotope, medical isotope, and plutonium-238 production alternatives within defined regions of influence at each of the candidate sites and along potential transportation routes. The regions of influence are specific to the type of effect evaluated, and encompass geographic areas within which any significant impact would be expected to occur. For example, human health risks to the general public from exposure to airborne contaminant emissions were assessed for an area within an 80-kilometer (50-mile) radius of the proposed facilities. The human health risks of shipping materials between sites were evaluated for populations living along roadways linking the DOE sites. Economic effects such as job and income changes were evaluated within a socioeconomic region of influence that include the county in which the site is located, and nearby counties in which a substantial portion of the site's workforce reside. Brief descriptions of the regions of influence are given in **Table 3–1**. More detailed descriptions of the region of influence and the methods used to evaluate impacts are presented in Appendix G.

Table 3–1 General Regions of Influence for the Affected Environment

Environmental Resouces	Region of Influence
Land use and visual resources	The site and the areas immediately adjacent to the site
Noise	The site, nearby offsite areas, access routes to the sites, and the transportation corridors between the sites
Air quality	The site, nearby offsite areas within local air quality control regions, and the transportation corridors between the sites
Water resources	Onsite and adjacent surface water bodies and groundwater
Geology and soils	Geologic and soil resources within the site and nearby offsite areas
Ecological resources	The site and adjacent areas where ecological resources may be affected by construction and/or operation
Cultural and paleontological resources	The area within the site and adjacent to the site boundary
Socioeconomics	The counties where at least 90 percent of site employees reside
Existing human health risk	The site, nearby offsite areas (within 80 kilometers [50 miles] of the site, and the transportation corridors between the sites) where worker and general population radiation, radionuclide, and hazardous chemical exposures may occur
Environmental justice	The minority and low-income populations within 80 kilometers (50 miles) of the site, and along the transportation corridors between the sites
Waste management	Waste management facilities on the site
Spent fuel management	Spent fuel management facilities on the site

At each of the candidate sites, baseline conditions for each environmental resource area were determined for ongoing operations from information provided in previous environmental studies, relevant laws and regulations, and other government reports and data bases. More detailed information of the affected environment at the candidate sites can be found in annual site environmental reports and site National Environmental Policy Act (NEPA) documents.

3.2 OAK RIDGE RESERVATION

ORR, established in 1943 as one of the three original Manhattan Project sites, is located on 13,949 hectares (34,424 acres) in Oak Ridge, Tennessee, and includes the Oak Ridge National Laboratory (ORNL), the Y–12 Plant (Y–12), and the East Tennessee Technology Park. It extends over parts of Anderson and Roane counties. The primary focus of ORNL is to conduct basic and applied scientific research and technology development. Y–12 engages in national security activities and manufacturing outreach to U.S. industries. The mission of the East Tennessee Technology Park is to maintain the infrastructure until decommissioning activities have been completed.

ORNL is one of the country's largest multidisciplinary and multiprogram laboratories and research facilities. Its primary mission is to perform leading-edge nonweapons research and development in energy, health, and the environment. Other missions include production of radioactive and stable isotopes, not available from other production sources; fundamental and applied research and development in sciences and materials development; research involving hazardous and radioactive materials; environmental research; and radioactive waste disposal. These activities are primarily sponsored by various offices within DOE, including the Office of Science; Office of Environmental Management; Office of Environment, Safety and Health; and Office of Nuclear Energy, Science and Technology.

Activities at ORR that are sponsored by the DOE Office of Defense Programs are performed at Y–12, and include storage of uranium and lithium materials and weapons parts; maintenance of the capability to fabricate components for nuclear weapons; dismantlement of nuclear weapon components returned from the national stockpile; processing of special nuclear materials; and special production support to DOE design agencies and other DOE programs.

Environmental management activities are in progress at each of the major facilities within ORR. These activities consist of environmental remediation and restoration, decontamination and decommissioning of surplus facilities, and waste management.

Non-DOE activities conducted at ORR include National Oceanic and Atmospheric Administration missions and programs, which conducts meteorological and atmospheric diffusion research, sponsored by itself and DOE. This work is performed at the Atmospheric Turbulence and Diffusion Laboratory and at field sites on ORR. This laboratory also provides services to DOE contractors and operates the Weather Instrument Telemetering Monitoring System for DOE. ORR also provides support to other Federal agencies such as the U.S. Nuclear Regulatory Commission (NRC), U.S. Environmental Protection Agency (EPA), and others, and private industry in conducting basic scientific research, engineering technology development and transfer, and educational research in the areas of health, environment, and energy.

3.2.1 Land Resources

Land resources include land use and visual resources. Each of these resource areas is described for the site as a whole, as well as for the locations of the proposed activities.

3.2.1.1 Land Use

Land use may be characterized by its current use and potential for the location of human activities. Natural resource attributes and other environmental characteristics could make a site more suitable for some land uses than for others. Changes in land use may have both beneficial and adverse effects on other resources such as ecological, cultural, geological, aquatic, and atmospheric.

3.2.1.1.1 General Site Description

Land bordering ORR is predominantly rural and is used primarily for residences, small farms, forest land, and pasture land. The city of Oak Ridge, has a typical urban mix of residential, public, commercial, and industrial land uses. It also includes almost all of ORR. There are four residential areas along the northern boundary of ORR; which have houses located within 30 meters (98 feet) of the site boundary.

Generalized land uses at ORR are shown in **Figure 3–1**. Land uses at the site include industrial, mixed industrial, institutional/research, institutional/environmental laboratory, and mixed research/future initiatives. Industrial and mixed industrial areas of the site include ORNL, Y–12, and the East Tennessee Technology Park. The institutional/research category applies to land occupied by central research facilities at ORNL and the Natural and Accelerated Bioremediation Field Research Center in Bear Creek Valley near Y–12. The institutional/environmental laboratory category includes the Oak Ridge Institute for Science and Education. Land within the mixed research/future initiative category includes land that is used or available for use in field research and land reserved for future DOE initiatives. Most mixed research and future initiatives areas are forested. Undeveloped forested lands on ORR are managed for multiple use and sustained yield of quality timber products. Although soils that would be identified as prime farmland occur on the site, that designation is waived because they are within the city of Oak Ridge (DOE 1999a). Only a small fraction of ORR has been disturbed by Federal activities, including the construction and operation of facilities, roadways, or other structures.

A large number of reservation-wide land uses overlay the primary land use categories and are officially designated as mixed uses. The largest mixed use is biological and ecological research in the Oak Ridge National Environmental Research Park, which is on 8,090 hectares (20,000 acres). The National Environmental Research Park, established in 1980, is used by the nation's scientific community as an outdoor laboratory for environmental science research on the impact of human activities on the eastern deciduous forest ecosystem (ORNL 1999). Recently, the Three Bend Scenic and Wildlife Management Refuge Area, on 1,215 hectares (3,000 acres), was set aside by DOE as a conservation and wildlife management area. The area is located in the ORR buffer zone, on Freels, Gallaher, and Solway Bends on the north shore of Melton Hill Lake (DOE 1999b). Additional details on land use plans at the site are provided in the *Oak Ridge National Laboratory, Land and Facilities Plan* (LMER 1999).

Proposed short-range projects at ORR include the Composite Materials Laboratory; Laboratory for Comparative and Functional Genomics; Mixed Waste Treatment Facility; Transuranic Waste Treatment Project Facility; Recycle and Materials Processing Facility; Process Waste Treatment Facility; Industrial Landfill Expansion and Upgrades; and Steam Plant Waste Water Treatment Facility. The Spallation Neutron Source Project and the Environmental Management of Waste Management Facility are in early stages of development. DOE completed an environmental assessment for economic development leasing of 387 hectares (957 acres) of land located to the northeast of the East Tennessee Technology Park. The lease is for 10 years (DOE 1996a:S-1). The Community Reuse Organization of East Tennessee is currently developing the site as an industrial park. The location of potential future facilities on ORR is shown in Figure 3–1.

Almost all of ORR lies within the city of Oak Ridge. A small portion of the northwest corner of the site lies outside the city in Roane County. The Oak Ridge Area Land Use Plan (city of Oak Ridge) designates ORR with the following land uses: residential, office/institutional, industrial, public, and undesignated. The city of Oak Ridge zoning ordinance classifies the entire ORR as a Forest, Agriculture, Industry, and Research District. The Roane County zoning ordinance does not classify ORR land; rather, it identifies ORR as a DOE Reservation.

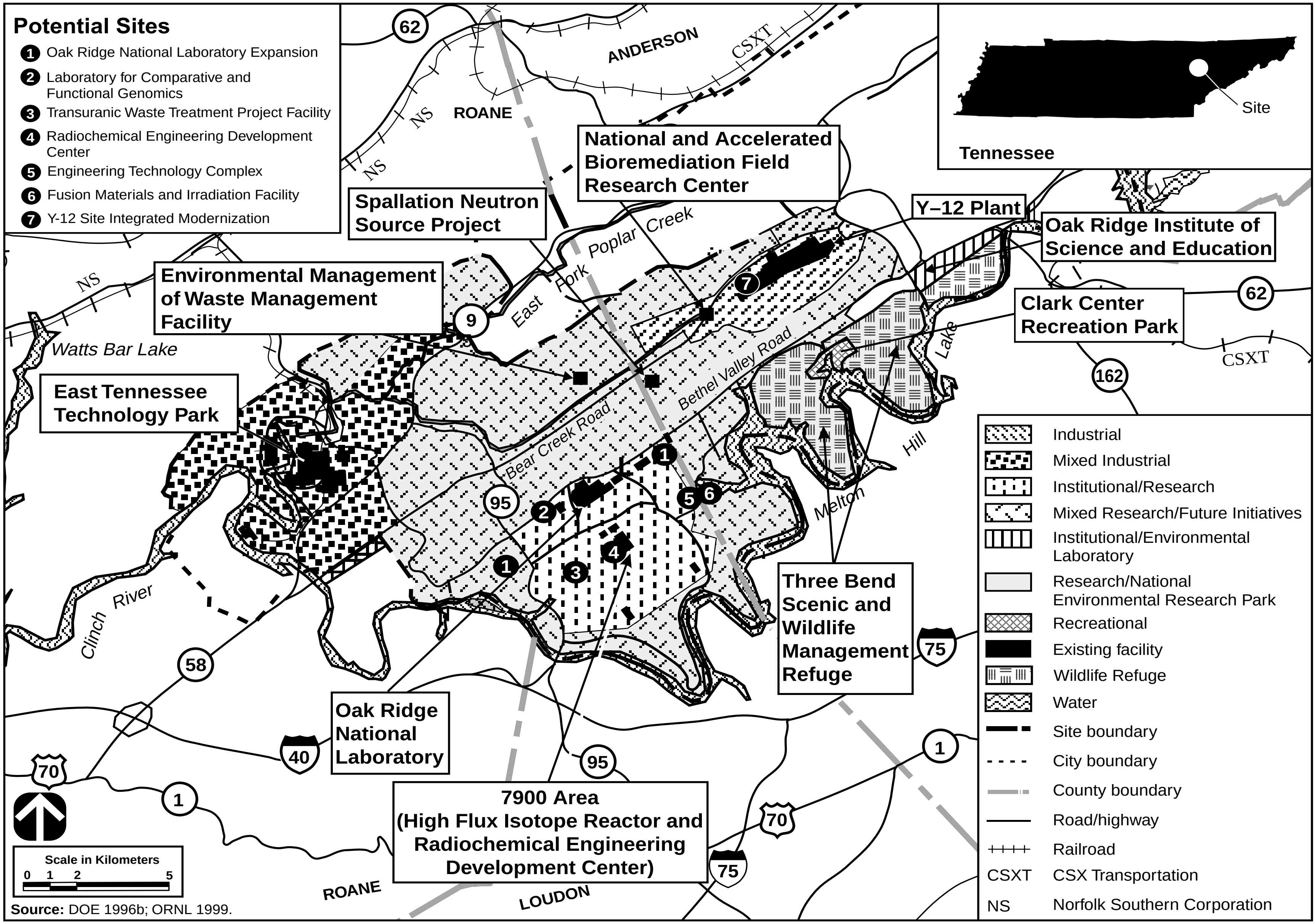

Figure 3–1 Generalized Land Use at Oak Ridge Reservation and Vicinity

3.2.1.1.2 Location of Proposed Activities

ORNL is primarily located within Bethel Valley between Haw and Chestnut Ridges, and covers 1,720 hectares (4,250 acres) of land (ORNL 1999). The site is classified as an industrial area that encompasses a number of facilities dedicated to energy research. REDC and HFIR are in the 7900 Area of ORNL. The 7900 Area is situated on a low ridge in Melton Valley, just to the southwest of Haw Ridge. The nearest public access to the 7900 Area is Bethel Valley Road is located about 1,500 meters (4,920 feet) to the north, and the nearest residential area is about 4,100 meters (13,450 feet) to the southwest. Land surrounding ORNL is largely forested and is classified as mixed research/future initiatives.

3.2.1.2 Visual Resources

Visual resources are natural and human-created features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape.

3.2.1.2.1 General Site Description

The ORR landscape is characterized by a series of ridges and valleys that trend in a northeast-to-southwest direction. The vegetation is dominated by deciduous forest mixed with some coniferous forest. Most of the original open field areas on the site have been planted in shortleaf and loblolly pine, although smaller areas have been planted in a variety of deciduous and coniferous trees. The DOE facilities are brightly lit at night, making them especially visible. The developed areas of ORR are consistent with the Bureau of Land Management's Visual Resource Management Class IV rating in which management activities dominate the view and are the focus of viewer attention (DOI 1986). The remainder of ORR ranges from a Visual Resource Management Class II to Class III rating. Management activities within these classes may be seen, but should not dominate the view.

The viewshed consists mainly of rural land. The city of Oak Ridge is the only adjoining urban area. Sensitive viewpoints affected by DOE facilities are primarily associated with Interstate 40, State Highways 58, 62, and 95, and Bethel Valley and Bear Creek Roads. The Clinch River/Melton Hill Lake, and the bluffs on the opposite side of the Clinch River also have views of ORR, but views of most of the existing DOE facilities are blocked by terrain and/or vegetation. Although only a small portion of State Highway 62 crosses ORR, it is a major route for traffic to and from Knoxville and other communities. The hilly terrain, heavy vegetation, and generally hazy atmospheric conditions limit views. Partial views of DOE water treatment plant facilities can be seen from the urban areas of the city of Oak Ridge.

3.2.1.2.2 Location of Proposed Activities

ORNL is one of several highly developed areas of ORR. As noted above, such areas are consistent with the Bureau of Land Management Visual Resource Management Class IV rating. While a large part of ORNL is visible from Bethel Valley Road, it is not visible to persons in offsite locations because of the presence of the Haw and Chestnut Ridges. The 7900 Area, which is located to the south of the main ORNL complex, is not visible from any public area.

3.2.2 Noise

Noise is unwanted sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities or diminish the quality of the environment.

3.2.2.1 General Site Description

Major noise emission sources within ORR include various industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). Most ORR industrial facilities are a sufficient distance from the site boundary that noise levels at the boundary from these sources are not measurable, or are barely distinguishable from background noise levels (DOE 1996b:3-192).

Sound level measurements have been recorded at various locations within and near ORR in the process of testing sirens and preparing support documentation for the Atomic Vapor Laser Isotope Separation site. The acoustic environment along the ORR site boundary in rural areas and at nearby residences away from traffic noise is typical of a rural location, with average day-night sound levels in the range of 35 to 50 decibels A-weighted (dBA). Areas near the site within Oak Ridge are typical of a suburban area, with the average day-night sound levels in the range of 53 to 62 dBA. Traffic is the primary source of noise at the site boundary and at residences located near roads. During peak hours, the plant traffic is a major contributor to traffic noise levels in the area (DOE 1996b:3-192).

The State of Tennessee has not established specific community noise standards applicable to ORR. The city of Oak Ridge has specific acceptable sound levels at property lines (City of Oak Ridge 1999). EPA guidelines for environmental noise protection recommend a day-night average sound level of 55 dBA as sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974:29). Land use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that yearly day-night average sound levels less than 65 dBA are compatible with residential land uses (14 CFR Part 150). These guidelines further indicate that noise levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures. It is expected that for most residences near ORR, the day-night average sound level is less than 65 dBA, and is compatible with the residential land use, although for some residences along major roadways noise levels may be higher.

3.2.2.2 Location of Proposed Activities

No distinguishing noise characteristics within ORNL have been identified. The ORNL 7900 Area is 2.5 kilometers (1.6 miles) from the site boundary; thus, the noise levels at the site boundary from these sources are barely distinguishable from background noise levels.

3.2.3 Air Quality

Air pollution refers to the introduction, directly or indirectly, of any substance into the air that could endanger human health, harm living sources and ecosystems and material property, and impair or interfere with the comfortable enjoyment of life or other legitimate uses of the environment. Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

3.2.3.1 General Site Description

The climate at ORR may be classified as humid continental, but is moderated by the influence of the Cumberland and Great Smoky Mountains. Winters are mild and summers are warm, with no noticeable extremes in precipitation, temperature, or winds (DOE 1996b:3-192). The average annual temperature is 13.7 °C (56.6 °F); average monthly temperatures range from a minimum of 2.2 °C (36 °F) in January to a maximum of 24.9 °C (76.8 °F) in July. The average annual precipitation is 138.5 centimeters (54.5 inches).

Prevailing winds at ORR generally follow the valley, up the valley from the southwest daytime, or down the valley from the northeast nighttime. The wind speed is less than 11.9 kilometers per hour (7.4 miles per hour) 75 percent of the time; tornadoes and winds exceeding 30 kilometers per hour (18 miles per hour) are rare (Hamilton et al. 1999:1-4).

ORR is located in the Eastern Tennessee and Southwestern Virginia Interstate Air Quality Control Region #207. The areas within this Air Quality Control Region are in attainment with respect to the National Ambient Air Quality Standards (NAAQS) for criteria pollutants (40 CFR Section 81.343). Applicable NAAQS and Tennessee State ambient air quality standards are presented in **Table 3–2**.

One Prevention of Significant Deterioration Class I area can be found in the vicinity of ORR. A Class I area is one in which very little increase in pollution is allowed due to the pristine nature of the area. This area, the Great Smoky Mountains, is located 48.3 kilometers (30 miles) southeast of ORR. ORR and its vicinity are classified as a Class II area in which more moderate increases in pollution are allowed. Since the creation of the Prevention of Significant Deterioration program in 1977, no Prevention of Significant Deterioration permits have been issued for any emission source at ORR (DOE 1996b:3-192).

The primary sources of criteria air pollutants at ORR are the steam plants at ORNL, Y–12, and the East Tennessee Technology Park. Other emission sources include the Toxic Substances Control Act incinerator; various process sources; vehicles, temporary emissions from construction activities; and fugitive particulate emissions from coal piles (DOE 1996b:3-192).

The existing ambient air pollutant concentrations attributable to sources at ORR are presented in Table 3–2. These concentrations are based on dispersion modeling, using emissions for the year 1992 (DOE 1996b:F-17). Only those pollutants that would be emitted by any of the alternatives evaluated in this NI PEIS are presented. As shown in Table 3–2, modeled concentrations associated with ORR emission sources represent a small percentage of the ambient air quality standard.

The closest offsite monitors are operated by the Tennessee Department of Environment and Conservation in Anderson County and the city of Knoxville. In 1999, these monitors reported a maximum 8-hour average carbon monoxide concentration of 4,466 micrograms per cubic meter and maximum 1-hour average concentration of 12,712 micrograms per cubic meter. An annual average particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) concentration of 30.0 micrograms per cubic meter and a maximum 24-hour average concentration of 71 micrograms per cubic meter were reported. Annual, 24-hour, and 3-hour average sulfur dioxide maximum concentrations of 7.9 micrograms per cubic meter, 78.5 micrograms per cubic meter, and 293 micrograms per cubic meter, respectively, were also reported in 1999 (EPA 2000).

Because ORR sources are limited or background concentrations of criteria pollutants are well below ambient standards, ORR emissions should not result in air pollutant concentrations that violate the ambient air quality standards.

Table 3–2 Comparison of Modeled Ambient Air Concentrations from Oak Ridge Reservation Sources with Most Stringent Applicable Standards or Guidelines, 1992

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meters)[a]	ORR Concentration (micrograms per cubic meters)
Criteria pollutants			
Carbon monoxide	8 hours	10,000[b]	5
	1 hour	40,000[b]	11
Lead	Calendar quarter	1.5[b]	0.05[c]
Nitrogen dioxide	Annual	100[b]	3
Ozone	1 hour	235[d]	(e)
PM_{10}	Annual	50[b]	1
	24 hours	150[b]	2
Sulfur dioxide	Annual	80[b]	2
	24 hours	365[b]	32
	3 hours	1,300[b]	80
Other regulated pollutants			
Gaseous fluoride	30 days	1.2[f]	0.2
	7 days	1.6[f]	0.3
	24 hours	2.9[f]	0.6[g]
	12 hours	3.7[f]	0.6[g]
Total suspended particulates	24 hours	150[f]	2[h]

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.
b. Federal and state standard.
c. 24-hour concentration used as a conservative estimate.
d. Federal 8-hour standard is currently under litigation.
e. Not directly emitted or monitored by the site.
f. State standard.
g. 8-hour concentration used as a conservative estimate.
h. Based on stack emissions of particulate matter only.

Note: Emissions of hazardous air pollutants not listed here have been identified at ORR, but are not associated with any alternative evaluated. The EPA revised the ambient air quality standards for particulate matter and ozone in 1997; however, these standards are under litigations. In 1999, new standards effective in September 16, 1997, could not be enforced. The ozone standard is a one-hour concentration of 235 micrograms per cubic meter (0.12 parts per million) (62 FR 38856). The 8-hour PM_{10} standard could not be enforced. The current annual PM_{10} standard is retained (62 FR 38652).
Source: DOE 1996b:3-193; 40 CFR Part 50; TDEC 1999a.

3.2.3.2 Location of Proposed Activities

HFIR and REDC are located in the 7900 Area of ORNL. The 7900 Area is situated in Melton Valley, south of the main portion of ORNL, between the Cumberland Mountains to the northwest, and the Great Smoky Mountains to the southeast. Terrain generally consists of ridges and valleys oriented southwest-northeast. The prevailing winds tend to follow this flow (LMER 1998:2.3-1, 2.3-2).

Current nonradiological emissions from the HFIR/REDC facilities are minimal, and result from wet chemistry and laboratory scale activities located at the facility. Additional nonradiological emissions result from maintenance activities inside the facility and in a small shop located adjacent to HFIR/REDC. Current

Tennessee Department of Environment and Conservation air pollution control rules do not require that these emissions be permitted or quantified (Smith 2000).

The primary sources of nonradiological air pollutants at ORNL include the facility steam plant, discussed in Section 3.2.3.1, and two small oil-fired boilers, which account for 98 percent of all allowable emissions. ORNL has 21 air permits covering 201 air emission sources. In 1998, the Tennessee Department of Environment and Conservation inspected all permitted sources and found them to be in compliance (Hamilton et al. 1999:2-23).

3.2.4 Water Resources

Water resources include all forms of surface water and subsurface groundwater.

3.2.4.1 Surface Water

Surface water includes marine or freshwater bodies that occur above the ground surface, including rivers, streams, lakes, ponds, rainwater catchments, embayments, and oceans.

3.2.4.1.1 General Site Description

The major surface water feature in the immediate vicinity of ORR is the Clinch River, which borders the site to the south and west. There are four major sub-drainage basins on ORR that flow into the Clinch River and are affected by site operations: Poplar Creek, East Fork Poplar Creek, Bear Creek, and White Oak Creek. Several smaller drainage basins, including Ish Creek, Grassy Creek, Bearden Creek, McCoy Branch, Kerr Hollow Branch, and Raccoon Creek, drain directly to the Clinch River. Each drainage basin takes the name of the major stream flowing through the area. The three major facilities at ORR each affect different basins of the Clinch River. Drainage from Y–12 enters both Bear Creek and East Fork Poplar Creek; the East Tennessee Technology Park drains mainly into Poplar Creek; and ORNL drains into White Oak Creek (DOE 1996b:3-194).

The Clinch River and connected waterways supply the raw water for ORR. The Clinch River has an average flow rate of 132 cubic meters (4,647 cubic feet) per second, as measured at the downstream side of Melton Hill Dam. The average flow rates of Grassy, Ish, and Bear Creeks in the ORR area are 0.08 cubic meters (2.8 cubic feet) per second, 0.05 cubic meters (1.8 cubic feet) per second, and 0.11 cubic meters (3.9 cubic feet) per second, respectively. The average flow rate at East Fork Poplar Creek is 1.46 cubic meters (51.4 cubic feet) per second. Y–12 uses 7,530 million liters (2 billion gallons) per year of water, and ORR uses 14,210 million liters (3,754 million gallons) per year. The ORR water supply system, which includes the city of Oak Ridge treatment facility (formerly the DOE treatment facility) and the East Tennessee Technology Park treatment facility, has a capacity of 121.5 million liters (32.1 million gallons) (DOE 1996b:3-194; LMER 1999:3-24).

The Clinch River water levels in the vicinity of ORR are regulated by a system of dams operated by the Tennessee Valley Authority. Melton Hill Dam controls the flow of the Clinch River along the northeast and southeast sides of ORR. Watts Bar Dam on the Tennessee River near the lower end of the Clinch River controls the flow of the Clinch River along the southwest side of ORR (DOE 1996b:3-194).

The surface streams of Tennessee are classified by the Tennessee Department of Environmental Conservation according to the Use Classifications for Surface Waters. Classifications are based on water quality, beneficial uses, and resident aquatic biota. The Clinch River is the only surface water body on or near ORR classified for domestic water supply. Unless otherwise specified in these rules, all streams in Tennessee are classified for use for fish and aquatic life, recreation, irrigation, and for livestock watering and wildlife. In addition, the

Clinch River and a short segment of Poplar Creek from its confluence with the Clinch River are also classified for industrial water supply use. White Oak Creek and Melton Branch are the only streams on ORR not classified for irrigation (TDEC 1999b). East Fork Poplar Creek is posted by the State of Tennessee with warnings against fishing and contact recreation (O'Donnell 2000).

Wastewater treatment facilities are located throughout ORR, including six treatment facilities at Y–12 that discharge to East Fork Poplar Creek, and three treatment facilities at ORNL that discharge into White Oak Creek Basin. These discharge points are included in existing National Pollutant Discharge Elimination System (NPDES) permits. Y–12 also has a permit to discharge wastewater to the Oak Ridge Treatment Facility. The East Tennessee Technology Park operates one sanitary sewage system discharging to Poplar Creek (DOE 1996b:3-196).

There are more than 400 NPDES-permitted outfalls at ORR associated with the three major facilities (Y–12 Plant, East Tennessee Technology Park, and ORNL); many of these are storm water outfalls. ORNL is currently operating under NPDES Permit TN0002941, which was renewed by the Tennessee Department of Environmental Conservation on December 6, 1996, and went into effect on February 3, 1997. This permit lists 164 point-source discharges that require compliance monitoring. Approximately 100 of these are storm drains, roof drains, and parking lot drains. Compliance was determined by approximately 6,500 laboratory analyses and measurements in 1998, in addition to numerous field observations by ORNL field technicians. The NPDES permit compliance rate was nearly 100 percent with only three permit exceedances. The NPDES permit limit compliance rate for all discharge points for the three major facilities in 1998 was over 99 percent (Hamilton et al. 1999:2-18, 2-19).

Compared with the previous permit, the new ORNL NPDES permit includes more stringent limits based on water quality criteria at a number of outfalls. The new permit also requires ORNL to conduct detailed characterization of numerous storm water outfalls, conduct an assessment and evaluation for the modification of the Radiological Monitoring Plan, develop and implement a Storm Water Pollution Prevention Plan, implement a revised Biological Monitoring and Abatement Program Plan, and develop and implement a Chlorine Control Strategy (Hamilton et al. 1999:2-19).

At ORR, water samples are collected and analyzed from 22 locations around the reservation to assess the impact of past and current DOE operations on the quality of local surface water. Sampling locations include streams, both upstream and downstream of ORR waste sources, and public water intakes. Samples are collected and analyzed for general water quality parameters at all locations, and are screened for radioactivity and analyzed for specific radionuclides, when appropriate. Based on 1998 sampling data, radionuclides were detected at all but two surface water locations, which were dry when sampling was attempted. High levels of radioactivity (gross alpha, gross beta, and total radioactive strontium) relative to applicable standards or criteria detected at First Creek within ORNL are attributed to leakage to backfill and soil from underground waste storage Tank W-1A at ORNL. Uranium isotopes were determined to be the primary alpha emitters. Excluding the First Creek site, the highest levels of gross beta, total radioactive strontium and tritium were detected at White Oak Creek at White Oak Dam and at White Oak Creek and Melton Branch, both downstream from ORNL. These data are consistent with historical data and with process or legacy activities nearby or upstream from these sites. Elevated levels of gross beta and total radioactive strontium have also been detected at Racoon Creek and Northwest Tributary. Locations that were checked for volatile organic compounds showed either low or undetectable levels. Polychlorinated biphenyls were not detected at either of the two sites sampled. Except for lead in 1 sample, and zinc in 3 samples out of 12 respectively, at the Clinch River upstream from all DOE inputs, no metals of human health concern were detected (Hamilton et al. 1999:7-6, 7-10, 7-11, D-5, D-8, D-11, D-13, D-14).

In Tennessee, the state's water right laws are established under the Water Quality Control Act. In effect, water rights are similar to riparian rights, in that designated usages of a water body cannot be impaired. Before withdrawing water from available supplies, a U.S. Army Corps of Engineers permit to construct intake structures would need to be obtained (DOE 1996b:3-196). In addition, projects and activities with the potential to affect aquatic resources could require permits from the Tennessee Department of Environment and Conservation and the Tennessee Valley Authority (Hamilton et al. 1999:2-20).

The Tennessee Valley Authority has conducted flood studies along the Clinch River, Bear Creek, and East Fork Poplar Creek. Portions of Y–12 lie within the 100- and 500-year floodplain boundaries of East Fork Poplar Creek. Studies have not been performed to delineate the 100- or 500-year floodplain boundaries of Grassy, Ish, and Bear Creeks in the western half of the facility (DOE 1996b:3-194).

The Tennessee Valley Authority has performed probable maximum flood studies along the Clinch River. The probable maximum flood is the flood that can be expected from the most severe combination of critical hydrometeorological conditions that are reasonably possible over the entire watershed. The probable maximum flood level along the Clinch River at the mouth of Bearden Creek occurred at elevation 248.3 meters (814.7 feet), while the probable maximum flood level at the mouth of White Oak Creek occurred at elevation 237.5 meters (779.3 feet). Based on the studies, most of ORR is above the probable maximum flood elevation along the Clinch River (LMER 1999:2-8).

3.2.4.1.2 Location of Proposed Activities

HFIR and REDC are in the 7900 Area on a low ridge in Melton Valley. HFIR overlooks Melton Branch, a tributary of White Oak Creek, with the REDC complex (Buildings 7920 and 7930) just north and upslope of HFIR (LMER 1998:2.4-1). Two reservoir systems supply water to ORNL facilities in Melton Valley and the 7900 Area, in particular, and also to facilities in Bethel Valley. The first is to the north of the 7900 Area on Chestnut Ridge and consists of a concrete storage reservoir with a capacity of 11.4 million liters (3.0 million gallons). A project to construct a second 3.0-million-liter (1.0-million-gallon) storage reservoir adjacent to the existing one is planned. The second system is on Haw Ridge and consists of two steel reservoir tanks, each with a storage capacity of 5.7 million liters (1.5 million gallons). These tanks are designated to provide reserve capacity for facilities in Melton Valley (e.g., HFIR). Water usage by ORNL Melton Valley facilities ranges from 9.5 million liters (2.5 million gallons) per day in the winter to a maximum of 18.9 million liters (5.0 million gallons) per day in the summer. The reservoir distribution system can supply 26.5 million liters (7.0 million gallons) per day (LMER 1999:3-25). These reservoirs are supplied by Y–12's water treatment plant, which receives its water from the Melton Hill Reservoir via a pumping station upstream from HFIR. Either of the two reservoirs is capable of supplying the normal 3,785 liters (1,000 gallons) per minute water requirements of HFIR (LMER 1998:2.4-1).

Sanitary wastewater from the 7900 Area is conveyed to the ORNL Sewage Treatment Plant, which provides primary, secondary, and tertiary sewage treatment. The Sewage Treatment Plant has a treatment capacity of 1.1 million liters (300,000 gallons) per day. Since 1997, treated flows have ranged from about 685,000 to 821,000 liters (181,000 to 217,000 gallons) per day (LMER 1999:3-62, 3-63). Process wastewater from HFIR and REDC is collected and conveyed to storage tanks prior to processing in the Process Waste Treatment Complex. Continuous monitoring of the wastewater in the collection system is used to route the wastewater to the appropriate treatment process. The Process Waste Treatment Complex consists of two facilities, Buildings 3544 and 3608, which provide both nonradiological and radiological effluent treatment. Treatment in Building 3608 consists of precipitation, filtration, air stripping, and neutralization to remove particulates, heavy metals, and organics, and to control pH before discharge. A clarifier is also used to perform process wastewater softening prior to transfer to Building 3544 for further treatment. Treatment capacity is 4.2 million liters (1.1 million gallons) per day. Treatment in Building 3544 consists of precipitation, filtration, and ion exchange. The maximum treatment capacity is 1.9 million liters (504,000 gallons) per day (LMER 1999:3-64, 3-65).

All wastewater treated at Buildings 3544 and 3608 is ultimately discharged to White Oak Creek through a single NPDES-permitted outfall (Outfall X12). The flow rate from this outfall averages about 2.08 million liters (550,000 gallons) per day, of which approximately 66,245 liters (17,500 gallons) per day are attributable to process wastewater from HFIR and REDC. The treated effluent from Outfall X12 meets NPDES water quality–based limits for metals and organics and DOE Derived Concentration Guides (DOE Order 5400.5), and is not toxic to aquatic species based on NPDES-required toxicity testing. HFIR and REDC also discharge dechlorinated cooling water and cooling tower blowdown to Melton Branch through NPDES-permitted outfalls 081 and 281. Discharge from Outfall 281, which is predominantly HFIR cooling tower blowdown, averages about 378,500 liters (100,000 gallons) per day in the warm months. The discharge rate from Outfall 081 averages approximately 265,000 liters (70,000 gallons) per day during the warm months and consists primarily of REDC cooling water (Valentine 2000).

Melton Branch, the primary stream in the immediate vicinity of HFIR and REDC, was analyzed to assess the potential for flooding from a locally intense storm, based on probable maximum precipitation events. The analysis determined that the relatively high elevation of the terrain and slope of the 7900 Area ensures that locally intense precipitation would not cause the Melton Branch to flood equipment at the HFIR site and vicinity. Likewise, the occurrence of a probable maximum flood at the mouth of White Oak Creek or along Melton Branch due to probable maximum precipitation events would not inundate the HFIR and vicinity. Surface runoff and facility drainage flows to either of two headwater tributaries of Melton Branch on the east and west sides, respectively, of the 7900 Area (LMER 1998:2.4-6, 2.4-7).

3.2.4.2 Groundwater

Aquifers are classified by Federal and state authorities according to use and quality. The Federal classifications include Classes I, II, and III groundwater. Class I groundwater is either the sole source of drinking water, or is ecologically vital. Classes IIA and IIB are current or potential sources of drinking water (or other beneficial use), respectively. Class III is not considered a potential source of drinking water and is of limited beneficial use.

3.2.4.2.1 General Site Description

ORR is in an area of sedimentary rocks of widely varying hydrological character. Groundwater flow occurs at shallow depths with discharge to nearby surface waters. Depth to groundwater is generally 5 to 9 meters (16 to 30 feet), but may be as little as 1.5 meters (5 feet). All aquifers are considered Class II (DOE 1996b:3-196).

Two broad hydrologic regimes have been characterized at ORR, each having fundamentally different hydrologic characteristics. The Knox Group and the Maynardville Limestone of the Conasauga Group constitute the Knox aquifer, in which flow is dominated by solution conduits formed along fractures and bedding planes. The less permeable ORR aquitard units constitute the second regime, in which flow is dominated by fractures (DOE 1999a:4-12; Hamilton et al. 1999:1-5–1-6). The combination of fractures and solution conduits in the dolostones and limestones of the Knox aquifer control flow over substantial areas, and rather large quantities of water may move relatively long distances. The Knox aquifer is the primary source of groundwater to many streams (base-flow), and most large springs on ORR receive discharge from the Knox Aquifer. Yields of some wells penetrating larger solution conduits are reported to exceed 3,784 liters (1,000 gallons) per minute. Units at ORR constituting the ORR aquitards include the Rome Formation, the Conasauga Group below the Maynardville Limestone, and the Chickamauga Group, and consist mainly of siltstone, shale, sandstone, and thinly bedded limestone of low to very low permeability. The typical yield of a well in the aquitards is less than 3.8 liters (1 gallon) per minute, and the base flows of streams draining areas underlain by the aquitards are poorly sustained because of such low flow rates (Hamilton et al. 1999:1-5).

Subsurface flow in both the Knox aquifer and in the aquitards is recharged mainly on ridges and is discharged into lakes, streams, springs, and seeps (DOE 1999a:4-12). Within ORR, the Knox aquifer underlies the major ridges (e.g., Chestnut and Copper Ridge) while the aquitard units underlie the valleys (e.g., Bear Creek, Bethel, and Melton valley) (Hamilton et al. 1999:1-7, 1-8). Because of the abundance of surface water and its proximity to the points of use, very little groundwater is used at ORR. Only one water supply well exists on ORR; it provides a supplemental water supply to an ORNL aquatic biology laboratory during extended droughts (DOE 1996b:3-196).

Groundwater samples are collected quarterly from representative wells selected from more than 1,000 monitoring wells throughout ORR. Samples collected from monitoring wells are analyzed for a standard set of parameters, including trace metals, volatile organic compounds, radioactive materials, and acidity/basicity. Background groundwater quality at ORR is generally good in the near-surface aquifer zones, and poor in the bedrock aquifer at depths greater than 305 meters (1,000 feet), due to high total dissolved solids (DOE 1996b:3-197). Information on more recent groundwater monitoring and chemical analysis is presented in the annual site environmental report (Hamilton et al. 1999).

Groundwater in the Bear Creek Valley near Y–12 and in the ORNL and East Tennessee Technology Park areas has been contaminated by hazardous chemicals and radionuclides from past process activities. The contaminated sites include past waste disposal sites, waste storage tanks, spill sites, and contaminated inactive facilities (DOE 1996b:3-197).

Industrial and drinking water supplies are primarily taken from surface water sources. However, single-family wells are common in adjacent rural areas not served by the public water supply system. Most of the residential wells in the immediate vicinity of ORR are south of the Clinch River (DOE 1996b:3-197).

Groundwater rights in the State of Tennessee are traditionally associated with the Reasonable Use Doctrine. Under this doctrine, landowners can withdraw groundwater as long as they exercise their rights reasonably in relation to the rights of others (DOE 1996b:3-199).

3.2.4.2.2 Location of Proposed Activities

Groundwater sampling performed in 1998 at 11 monitoring wells located in waste area groupings 8 and 9 in Melton Valley, encompassing HFIR and REDC, showed evidence of radioactivity attributable to former effluent-handling practices in the 7900 Area (Smith 2000). Two of the sampled wells exceeded the Federal drinking water standards: one well for tritium contamination, and a second well for gross beta activity and total radioactive strontium contamination. Gross alpha activity ranged from undetectable to 6.7 picocuries per liter; the drinking water standard is 15 picocuries per liter. Gross beta activity ranged from undetectable to 1,400 picocuries per liter; the drinking water standard is 50 picocuries per liter. Total radioactive strontium ranged from undetectable to 630 picocuries per liter; the drinking water standard is 8 picocuries per liter. Tritium ranged from undetectable to 53,000 picocuries per liter; the drinking water standard is 20,000 picocuries per liter. Note that groundwater is not used for drinking water at ORNL (Hamilton et al. 1999:5-27, 5-33).

3.2.5 Geology and Soils

Geologic resources are consolidated or unconsolidated earth materials, including ore and aggregate materials, fossil fuels, and significant landforms. Soil resources are the loose surface materials of the earth in which plants grow, usually consisting of disintegrated rock, organic matter, and soluble salts.

3.2.5.1 General Site Description

ORR is in the southwestern portion of the Valley and Ridge physiographic province in east-central Tennessee. The topography consists of alternating valleys and ridges that have a southwest-northeast trend, with most ORR facilities occupying the valleys (DOE 1996b:3-200). The topography reflects the underlying geology, which consists of a sequence of sedimentary rocks deformed by a series of major southeast-dipping thrust faults. The ridges are underlain by relatively erosion-resistant rocks, while weaker rock strata underlie the valleys (DOE 1999a:4-1, 4-3). Y–12 is in Bear Creek Valley between Pine and Chestnut Ridges, East Tennessee Technology Park is located along Poplar Creek between McKinney and Pine Ridges, and ORNL is in Bethel Valley between Haw and Chestnut Ridges. The 7900 Area of ORNL is on a low ridge in Melton Valley, south of Haw Ridge. ORNL and the East Tennessee Technology Park are underlain primarily by calcareous siltstones and silty to clean limestone of the Chickamauga Group. The Conasauga Group underlies Y–12 and the 7900 Area, which is composed of shales, calcareous siltstones, and silty-to-clean limestones. Pine Ridge and Haw Ridge are underlain by the Rome Formation, which consists of sandstone with thin shale interbeds. Chestnut Ridge is underlain by the cherty dolomite of the Knox Group. The Knox Group typically has well-developed karst features such as sinkholes, large solution cavities, and caves (DOE 1996b:3-200; 1999a:4-3–4-5). Structurally, two major thrust faults factor into the subsurface geology of ORR. Chestnut Ridge and Bethel Valley are underlain by the White Oak Mountain thrust fault. Haw Ridge and Melton Valley are underlain by the Copper Creek thrust fault. These faults formed during the Pennsylvanian-Permian periods (occurring about 320 to 245 million years ago) but have not been historically active (DOE 1999a: 4-3–4-5). The present topography of the valleys is a result of stream action preferentially eroding the softer shales and limestones; the ridges are composed of relatively more resistant sandstones and dolomites. With the exception of strata suited to hard-rock quarrying for stone and aggregate (e.g., limestone, shale), no economically viable geologic resources have been identified at ORR (DOE 1996b:3-200).

There is no evidence of capable faults in the Valley and Ridge physiographic province, or within the rocks comprising the Appalachian Basin structural feature, where ORR is located. A capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years, or recurrent movement within the past 500,000 years (10 CFR Part 100, Appendix A). The nearest capable faults are approximately 480 kilometers (298 miles) northwest in the New Madrid (Reelfoot rift) fault zone. Historical earthquakes occurring in the Valley and Ridge are not attributable to fault structures in underlying sedimentary rocks, but rather occur at depth in basement rock (DOE 1999a:4-9; LMER 1998: 2.5-19, 2.5-20).

The historical seismicity of the southeastern United States relative to ORR has been extensively reviewed in recent years. Since the New Madrid earthquakes of 1811-1812, at least 27 other earthquakes with a Modified Mercalli Intensity of III to VI (**Table 3–3**) have been felt in the Oak Ridge area (DOE 1996b:3-200; LMER 1998:2.5-16, 2.5-17, 2.5-29, 2.5-30). Second to the New Madrid earthquakes in intensity, the Charleston, South Carolina earthquake of 1886, located about 515 kilometers (320 miles) from ORR, is estimated to have produced effects at ORR equivalent to Modified Mercalli Intensity VI (LMER 1998:2.5-29). One of closest and most intense seismic events occurred in 1930, approximately 8 kilometers (5 miles) from ORR, and had a Modified Mercalli Intensity of V at the site. The largest most recent earthquake in eastern Tennessee registered 4.6 on the Richter scale and occurred on November 30, 1973, in Maryville, Tennessee, about 32 kilometers (20 miles) southeast of ORR. This earthquake produced a Modified Mercalli Intensity of V to VI at ORR (as estimated at HFIR) (DOE 1996b:3-200; LMER 1998: 2.5-17, 2.5-30). The region has

Table 3–3 The Modified Mercalli Intensity Scale of 1931, with Approximate Correlations to Richter Scale and Maximum Ground Acceleration[a]

Modified Mercalli Intensity[b]	Observed Effects of Earthquake	Approximate Richter Magnitude[c]	Maximum Ground Acceleration[d](g)
I	Usually not felt	Less than 2	Negligible
II	Felt by persons at rest on upper floors or favorably placed	2 to 3	Less than 0.003
III	Felt indoors; hanging objects swing; vibration like passing of light truck occurs; might not be recognized as earthquake	3	0.003 to 0.007
IV	Felt noticeably by persons indoors, especially in upper floors; vibration occurs like passing of heavy truck; jolting sensation; standing automobiles rock; windows, dishes, and doors rattle; wooden walls and frames may creak	4	0.007 to 0.015
V	Felt by nearly everyone; sleepers awaken; liquids disturbed and may spill; some dishes break; small unstable objects are displaced or upset; doors swing; shutters and pictures move; pendulum clocks stop or start	Between 4 and 5	0.015 to 0.03
VI	Felt by all; many are frightened; persons walk unsteadily; windows and dishes break; objects fall off shelves, pictures fall off shelves and walls; furniture moves or overturns; weak masonry cracks; small bells ring; trees and bushes shake	5	0.03 to 0.09
VII	Difficult to stand; noticed by car drivers; furniture breaks; damage moderate in well built ordinary structures; poor quality masonry cracks and breaks; chimneys break at roof line; loose bricks, stones, and tiles fall; waves appear on ponds and water is turbid with mud; small earthslides; large bells ring	6	0.07 to 0.22
VIII	Automobile's steering affected; some walls fall; twisting and falling of chimneys, stacks, and towers; frame houses shift if on unsecured foundations; damage slight in specially designed structures, considerable in ordinary substantial buildings; changes in flow of wells or springs; cracks appear in wet ground and steep slopes	Between 6 and 7	0.15 to 0.3
IX	General panic; masonry heavily damaged or destroyed; foundations damaged; serious damage to frame structures, dams and reservoirs; underground pipes break; conspicuous ground cracks	7	0.03 to 0.7
X	Most masonry and frame structures destroyed; some well built wooden structures and bridges destroyed; serious damage to dams and dikes; large landslides; rails bent	8	0.45 to 1.5
XI	Rails bent greatly; underground pipelines completely out of service	Between 8 and 9	0.5 to 3
XII	Damage nearly total; large rock masses displaced; objects thrown into air; lines of sight distorted	9	0.5 to 7

a. This table illustrates the approximate correlation between the Modified Mercalli Intensity scale, the Richter scale, and maximum ground acceleration.
b. Intensity is a unitless expression of observed effects.
c. Magnitude is an exponential function of seismic wave amplitude, related to the energy released.
d. Acceleration is expressed in relation to the earth's gravitational acceleration (g).
Source: DOE 1996b:3-39.

continued to be seismically active. In 1987, a magnitude 4.2 earthquake occurred about 38 kilometers (24 miles) from ORR producing a Modified Mercalli Intensity of VI at its epicenter. Since 1995, two earthquakes with a reported Modified Mercalli Intensity of at least III and two with a Modified Mercalli Intensity of V have occurred within approximately 90 kilometers (56 miles) of the ORR (USGS 2000a). Based on historical observations, the maximum earthquake for ORR would be a Modified Mercalli Intensity VIII event, having an epicenter at ORR (DOE 1999a:4-9, 4-10). Numerous studies have been conducted as part of establishing the design-basis earthquake for evaluating and designing new ORR facilities. For this purpose, an earthquake producing an effective peak-ground acceleration of 0.15 g has been established and calculated to have an annual probability of occurrence of about 1 in 1,000 (LMER 1998:2.5-18, 2.5-59). For comparison, an earthquake with a peak acceleration of 0.32 g has an annual probability of occurrence of 1 in 5,000 (Barghusen and Feit 1995:2.8-14).

Measures of peak (ground) acceleration are indicative of what an object on the ground would experience during an earthquake. This motion is customarily expressed in units of g (percent of gravity). While peak acceleration is generally adequate to approximate what a short structure would experience in terms of horizontal force during an earthquake, it does not account for the range of energies experienced by a building during an earthquake, particularly for taller buildings. Thus, building design based on peak acceleration alone does not provide a uniform margin against collapse. However, the U.S. Geological Survey (USGS) has developed new seismic hazard maps as part of the National Seismic Hazard Mapping Project that are based on response spectral acceleration.

Spectral acceleration maps account for the natural period of vibration of structures (i.e., short buildings have short natural periods [up to 0.6 seconds] and taller buildings longer periods [$\geq$0.7 seconds]) (USGS 2000b). These maps have been adapted for use in the new *International Building Code* (ICC 2000) (Figures 1615(1) and 1615(2) in the code) and depict maximum considered earthquake ground motion of 0.2 and 1.0 second spectral response acceleration, respectively, based on a 2 percent probability of exceedance in 50 years. This corresponds to an annual recurrence interval of about 1 in 2,500. ORR lies within the 0.50 to 0.60 g mapping contours for a 0.2-second spectral response acceleration and the 0.10 to 0.15 g contours for a 1.0-second spectral response acceleration.

There is no volcanic hazard at ORR. The area has not experienced volcanic activity within the last 230 million years (DOE 1996b:3-200).

Four general soil map units occur on ORR. These are described based on the Anderson County soil survey (Moneymaker 1981:5-7). The soil survey for Roane County has not been updated since 1942 (DOA 1942) and does not specifically identify general soil map units. The four soil map units of ORR are Fullerton-Claiborne-Bodine; Collegedale-Gladeville-Rock outcrop; Lehew-Armuchee-Muskingum; and Armuchee-Montevallo-Hamblen units. Soils of the Fullerton-Claiborne-Bodine unit may be described as deep, rolling-to-steep, well-drained cherty and noncherty soils underlain by dolomite. They occur on rolling ridgetops and on all aspects of steep side slopes. The Collegedale-Gladeville-Rock outcrop soil unit consists of deep and shallow, rolling and hilly well-drained soils that are underlain by limestone and have many outcrops of limestone. Soils of this group occur on uplands. Soils of the Lehew-Armuchee-Muskingum unit are moderately deep, steep, well-drained soils underlain by multicolored shale, siltstone, and sandstone. This unit is found on high winding ridges. The Armuchee-Montevallo-Hamblen soil unit is made up of shallow-to-deep, steep to nearly level, well-drained and moderately well-drained soils underlain by shale. This unit occurs on uplands and bottomlands.

Prime farmland is land with the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is available for these uses. While there are soils that would be classified as prime farmland on ORR, that designation is waived within the city limits of Oak Ridge and ORR (DOE 1999a:4-7).

3.2.5.2 Location of Proposed Activities

There are no capable faults on or near ORR. As noted above, ORNL is underlain primarily by calcareous siltstones and silty-to-clean limestone of the Chickamauga Group. Melton Valley, and the 7900 Area in particular, are underlain by the interbedded limestones and shales of the Conasauga Group (DOE 1999a:4-4, 4-5; LMER 1998:2.5-48). Karst features are less developed in the Chickamauga Group and in other groups than in the Knox Group. Cavities encountered are smaller and often clay-filled, and caves are sparse and typically small, with the same observation expected for the Conasauga Group (LMER 1999:2-8). Soils of ORNL, including the 7900 Area, are highly disturbed and, as is the case for other developed areas of ORR (e.g., Y–12), would be classified as Urban Land. Urban Land includes areas where more than 80 percent of the surface is covered with industrial plants, paved parking lots, and other impervious surfaces (Moneymaker 1981:44).

3.2.6 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species.

3.2.6.1 Terrestrial Resources

This section addresses the plant and animal communities of ORR and includes a plant community map of the site. Terrestrial resources are described for the site as a whole, as well as the proposed facility locations.

3.2.6.1.1 General Site Description

Plant communities at ORR are characteristic of the intermountain regions of central and southern Appalachia. Only a small fraction of ORR has been disturbed by Federal activities; the remainder of the site has reverted to or been planted with natural vegetation. The vegetation of ORR has been categorized into seven plant communities (**Figure 3–2**). Pine and pine-hardwood forest is the most extensive plant community on the site. Another abundant community is the oak-hickory forest, which is commonly found on ridges throughout ORR. Northern hardwood forest and hemlock-white pine-hardwood forest are the least common forest community types on the site. Forest resources on ORR are managed for multiple use and sustained yield of quality timber products (DOE 1996b). Over 1,100 vascular plants species are found on ORR (LMER 1999).

Animal species found on ORR include 59 amphibians and reptiles, 260 birds, and 38 mammals (LMER 1999). Animals commonly found on the site include the American toad, eastern garter snake, Carolina chickadee, northern cardinal, white-footed mouse, and raccoon. Most of ORR is within the Oak Ridge Wildlife Management Area. Wildlife management is carried out by the Tennessee Wildlife Resources Agency in cooperation with ORNL's Environmental Sciences Division. The whitetail deer and turkey are the only species hunted on site; however, other game animals are also present (LMER 1999). Raptors, such as the northern harrier and great horned owl, and carnivores, such as the gray fox and mink, are ecologically important groups on ORR. A variety of migratory birds have been found at ORR.

3.2.6.1.2 Location of Proposed Activities

Vegetative communities in the vicinity of the 7900 Area are typical of ORR as a whole, with pine, pine-hardwood forests, cedar, cedar-pine, cedar hardwood, and oak-hickory forests being the predominant community types (Figure 3–2). Fauna of the area are similar to that found throughout ORR. The 7900 Area itself is highly developed and provides minimal wildlife habitat.

3.2.6.2 Wetlands

Wetlands include "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation

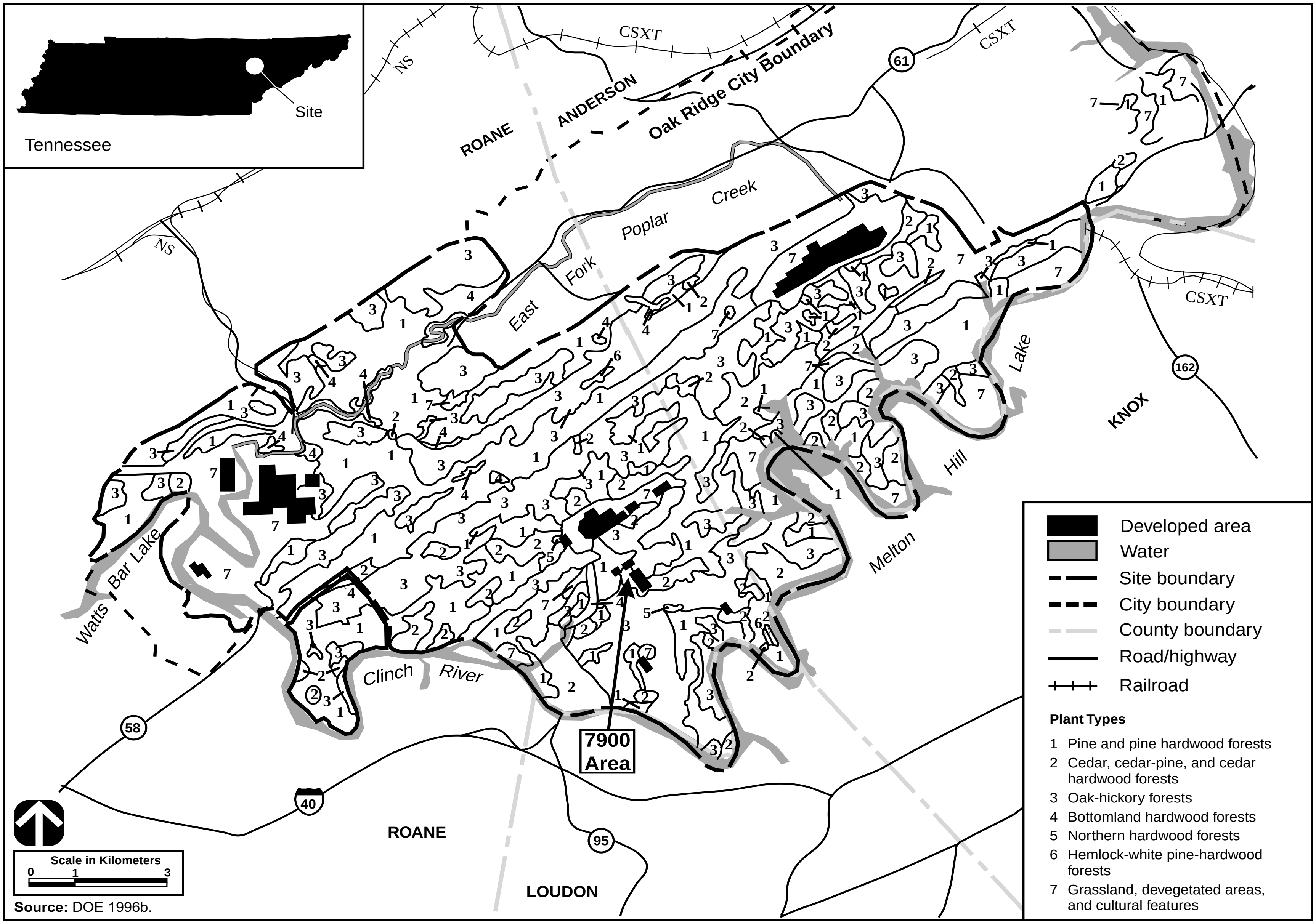

Figure 3–2 Distribution of Plant Communities at the Oak Ridge Reservation

typically adapted for life in saturated soil conditions" (33 CFR Section 328.3). Wetlands are described for ORR as a whole, as well as for the proposed facility locations.

3.2.6.2.1 General Site Description

Approximately 235 hectares (580 acres) of wetlands occur on ORR (LMER 1999). These include emergent, scrub and shrub, and forested wetlands associated with bays (embayments) of the Melton Hill and Watts Bar Lake, areas bordering major streams and their tributaries (riparian), old farm ponds, and groundwater seeps. Well-developed communities of emergent wetland plants in the shallow embayments of the two reservoirs typically intergrade into forested wetland plant communities, which extend upstream through riparian areas associated with streams and their tributaries. Old farm ponds on ORR vary in size and support diverse plant communities and fauna. Although most riparian wetlands on ORR are forested, areas within utility rights-of way, such as those in Bear Creek and Melton Valley, support emergent wetland vegetation.

3.2.6.2.2 Location of Proposed Activities

There are six wetlands in the vicinity of the 7900 Area, including one small, unclassified wetland (Rosensteel 1996:25, 42); however, none are within the developed area. These wetlands, which were identified using the criteria and methods set forth in the *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987), are generally classified as palustrine forested broad-leaved deciduous wetlands, although one also includes areas of emergent vegetation. Not including the unclassified wetland, the size of these areas range from 0.14 hectare (0.3 acre) to 1.23 hectares (3.0 acres). Mowing routinely disturbs two of the six wetlands.

3.2.6.3 Aquatic Resources

Aquatic resources at ORR are described for the site as a whole, as well as for the proposed facility locations.

3.2.6.3.1 General Site Description

Aquatic habitat on or adjacent to ORR ranges from small, free flowing streams in undisturbed watersheds to larger streams with altered flow patterns due to dam construction. These aquatic habitats include tailwaters, impoundments, reservoir embayments, and large and small perennial streams. Aquatic areas in ORR also include seasonal and intermittent streams and old farm ponds.

Sixty-three fish species have been collected on ORR (LMER 1999). The minnow family has the largest number of species and is numerically dominant in most streams. Fish species representative of the Clinch River in the vicinity of ORR are shad, herring, common carp, catfish, bluegill, crappie, and freshwater drum. The most important fish species taken commercially in the ORR area are common carp and catfish. Commercial fishing is permitted on the Clinch River downstream from Melton Hill Dam. Area recreational species consist of crappie, largemouth bass, sauger, sunfish, and catfish. Sport fishing is not permitted within ORR.

3.2.6.3.2 Location of Proposed Activities

ORNL is drained by White Oak Creek. The upper portion of the creek is similar to the upper reaches of other streams originating on Chestnut Ridge. These streams typically have alternating riffle and pool habitats. The stoneroller and blacknose dace are the fish species most commonly collected; 24 taxa of macroinvertebrates are present. Historically, operations at ORNL have had an adverse ecological effect on White Oak Creek. For example, the influence of ORNL is reflected in the fact that benthic macroinvertebrate populations are less diverse downstream of the site than upstream (DOE 1999a).

There are three Aquatic Reference Areas and one Reference Area in the ORNL area: Aquatic Reference Areas 3, 4, and 5, and Reference Area 28 (Pounds, Parr, and Ryon 1993:5,15-17). Reference Areas are areas that are representative of the communities of the southern Appalachian region or that possess unique biotic features. Aquatic Reference Area 3, Northwest Tributary, is a second-order, frequently intermittent stream that flows along the wooded base of Haw Ridge, but with mowed fields, parking lots, and experimental ponds on the opposite bank. Aquatic Reference Area 4, First Creek, and Aquatic Reference Area 5, Fifth Creek, are first-order, spring-fed streams that flow out of Chestnut Ridge. Each area has rich benthic fauna, but is somewhat more limited with regard to the number of fish species present. Reference Area 28, Spring Pond, is a small spring-fed pond with unusually clear water for ponds on ORR; it is dominated by Nutall waterweed.

3.2.6.4 Threatened and Endangered Species

Endangered species are those plants and animals in danger of extinction throughout all or a large portion of their range. Threatened species are those species likely to become endangered within the foreseeable future. Threatened and endangered species are described for ORR as a whole, as well as for the proposed facility locations.

3.2.6.4.1 General Site Description

Eighty-four Federal and state-listed threatened, endangered, and other special status species may be found on and in the vicinity of ORR, as shown in Table 3.6.6–1 of the *Storage and Disposition of Weapons Usable Fissile Materials Final PEIS* (DOE 1996b:3-204–3-206). The gray bat (endangered) and bald eagle (threatened, but proposed to be delisted) are the only federally listed threatened or endangered species observed on or near ORR. The bald eagle has been seen on Melton Hill and Watts Bar Lakes (DOE 1996b). A dead gray bat was found several years ago at Y–12 (Barclay 1999). The Indiana bat (endangered) has not been reported from the site (Mitchell et al. 1996a). State-listed threatened or endangered species observed on ORR include the peregrine falcon, osprey, and 14 plant species. No critical habitat for threatened or endangered species, as defined in the Endangered Species Act, exists on ORR or adjacent lakes. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service. Consultation has also been initiated with the state.

3.2.6.4.2 Location of Proposed Activities

No threatened, endangered, or sensitive plant or animal species have been recorded at or in the vicinity of the 7900 Area. Further, there is no potential habitat for such species confirmed in close proximity to the area (Parr 1999).

3.2.7 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. The three general categories of cultural resources addressed in this section are prehistoric, historic, and Native American. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age, and may be sources of information on paleoenvironments and the evolutionary development of plants and animals.

3.2.7.1 Prehistoric Resources

Prehistoric resources are physical properties that remain from human activities that predate written records.

3.2.7.1.1 General Site Description

More than 20 cultural resources surveys have been conducted at ORR. About 90 percent of ORR has received at least some preliminary walkover or archival-level study, but less than 5 percent has been intensively surveyed. Most cultural resources studies have occurred along the Clinch River and adjacent tributaries. Prehistoric sites recorded at ORR include villages, potential burial mounds, camps, quarries, a chipping station, limited activity locations, and shell scatters. More than 45 prehistoric sites have been recorded at ORR to date. At least 13 prehistoric sites are considered potentially eligible for the National Registry of Historic Places, but most of these sites have not yet been evaluated. Additional prehistoric sites may be anticipated in the unsurveyed portions of ORR. In 1994, a Programmatic Agreement concerning the management of historic and cultural properties at ORR was executed among the DOE Oak Ridge Operation Office, the Tennessee State Historic Preservation Officer, and the Advisory Council on Historic Preservation. This agreement was executed to satisfy DOE's responsibilities regarding Sections 106 and 110 of the National Historic Preservation Act, and resulted in DOE preparing a cultural resources management plan for ORR (Souza, DuVall, and Tinker 1997).

3.2.7.1.2 Location of Proposed Activities

No prehistoric properties have been located within or immediately adjacent to the 7900 Area (Souza, DuVall, and Tinker 1997:F-5).

3.2.7.2 Historic Resources

Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are generally considered to be those that date no earlier than 1492.

3.2.7.2.1 General Site Description

Several historic resources surveys have been conducted at ORR. Historic resources identified at ORR include both archaeological remains and standing structures. Documented log, wood frame, or fieldstone structures include cabins, barns, churches, gravehouses, springhouses, storage sheds, smokehouses, log cribs, privies, henhouses, and garages. Archaeological remains consist primarily of foundations, roads, and trash scatters. A total of 32 cemeteries are located within the present boundaries of ORR (Souza, DuVall, and Tinker 1997). More than 240 historic resources have been recorded at ORR, and 38 of those sites may be considered potentially eligible for listing on the National Registry of Historic Places. Freel's Cabin and two church structures, George Jones Memorial Baptist Church and the New Bethel Baptist Church, are listed on the National Registry. These structures date from before the establishment of the Manhattan Project. National Registry sites associated with the Manhattan Project include the Graphite Reactor at ORNL, listed on the National Registry of Historic Places as a National Historic Landmark, and three traffic checkpoints, Bear Creek Road, Bethel Valley Road, and Oak Ridge Turnpike Checking Stations (DOE 1999a). Many other buildings and facilities at ORR are associated with the Manhattan Project and are eligible for the National Registry. Historic building surveys have been completed for the Oak Ridge Townsite, ORNL, Y–12, the East Tennessee Technology Park, and the Oak Ridge Institute for Science and Education (Souza, DuVall, and Tinker 1997). Additional historic sites may be anticipated in the unsurveyed portions of ORR. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office.

3.2.7.2.2 Location of Proposed Activities

A survey was conducted in 1993 to identify properties at ORNL that are included or are eligible for inclusion in the National Register of Historic Places. Eligible properties include the ORNL Historic District; Buildings 7001 and 7002 in the ORNL East Support Area; the Molten Salt Reactor Experiment Facility (Building 7503, previously known as the Aircraft Reactor Experiment Building); the Tower Shielding Facility; and White Oak Lake and Dam. Of these structures, the Molten Salt Reactor Experiment Facility is the closest eligible property to the 7900 Area. It is located about 0.4 kilometer (0.25 mile) to the north of REDC and HFIR (Souza, DuVall, and Tinker 1997:3-70).

3.2.7.3 Native American Resources

Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. In addition, cultural values are placed on natural resources such as plants, which have multiple purposes within various Native American groups. Concepts of sacred space that create the potential for land use conflicts are of primary concern.

3.2.7.3.1 General Site Description

The Overhill Cherokee Tribe occupied portions of the Tennessee, Hiwassee, Clinch, and Little Tennessee River Valleys in the 1700s. Overhill Cherokee villages consisted of a large townhouse, a summer pavilion, and a plaza, and residences had both summer and winter structures. Subsistence was based on hunting, gathering, and horticulture. The Cherokee were relocated to the Oklahoma territory in 1838, although some individuals refused to be moved and some Cherokee later returned to the area from Oklahoma. Resources that may be sensitive to Native American groups include remains of prehistoric and historic villages, ceremonial lodges, cemeteries, burials, and traditional plant gathering areas. Apart from prehistoric archaeological sites, to date no Native American resources have been identified at ORR.

3.2.7.3.2 Location of Proposed Activities

No Native American sacred sites or cultural items have been located within or immediately adjacent to the 7900 Area (Souza, DuVall, and Tinker 1997:3-66, 3-69, F-5).

3.2.7.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. Paleontological remains consist of fossils and their associated geological information.

3.2.7.4.1 General Site Description

The majority of geological units with surface exposures at ORR contain paleontological materials. Paleontological materials consist primarily of invertebrate remains, and these have relatively low research potential.

3.2.7.4.2 Location of Proposed Activities

Paleontological resources at ORNL would not be expected to differ from those found elsewhere on ORR.

3.2.8 Socioeconomics

Statistics for employment and regional economy are presented for the regional economic area, as defined in Appendix G.8, which encompasses 15 counties around ORR in Tennessee. Statistics for population, housing, community services, and local transportation are presented for the region of influence, a four-county area in which 89.9 percent of all ORR employees reside (**Table 3–4**). In 1998, ORR employed 14,215 persons (about 3.4 percent of the regional economic area civilian labor force) (DOE 1999c).

Table 3–4 Distribution of Employees by Place of Residence in the ORR Region of Influence, 1998

County	Number of Employees	Total Site Employment (percent)
Anderson	4,061	28.6
Knox	5,615	39.5
Loudon	828	5.8
Roane	2,275	16.0
Region of influence total	12,779	89.9

Source: DOE 1999c.

3.2.8.1 Regional Economic Characteristics

Between 1980 and 1990, the civilian labor force in the ORR regional economic area increased 16.2 percent to the 1990 level of 412,803. In 1998, the unemployment rate in the regional economic area was 4.1 percent, which was slightly less than the unemployment rate for Tennessee (4.8 percent) (DOL 2000).

In 1993, services represented the largest sector of employment in the regional economic area (26 percent), followed by retail (19 percent), and manufacturing (18 percent). In Tennessee, the services sector comprised 26 percent of total employment, followed by manufacturing (19 percent), and retail (17 percent) (DOE 1996b).

3.2.8.2 Population and Housing

In 1998, the ORR region of influence population totaled 527,040. From 1990 to 1998, the region of influence population grew by 9.2 percent, compared to 11.3 percent growth in Tennessee. Within the region of influence, Loudon County experienced the greatest population increase, 24.9 percent, while Anderson County's population increased by only 4.2 percent (Forstall 1995, DOC 1999). Between 1980 and 1990, the number of housing units in the region of influence increased by about 13.8 percent, nearly 2 percent less than the increase for the entire State of Tennessee. In 1995, the total number of owner and rental housing units within the region of influence was 214,700. In 1990, the homeowner and rental vacancy rates for the region of influence were 1.7 percent, compared to the state's rate of 8.5 percent (DOE 1996c).

3.2.8.3 Community Services

3.2.8.3.1 Education

School districts providing public education in the ORR region of influence operated at capacities ranging from 74.7 to 100 percent. Total student enrollment in the region of influence in 2000 was 70,493. The average student-to-teacher ratio was 16.7:1 (Davis 2000; Garza 2000; Groover 2000; McKinney 2000; Pierce 2000).

3.2.8.3.2 Public Safety

In 2000, a total of 1,513 sworn police officers served the four-county region of influence. The average officer-to-population ratio was 2.8 officers per 1,000 persons (HPI 1999). In 2000, 1,293 paid and volunteer firefighters provided fire protection services in the ORR region of influence. The average firefighter-to-population ratio was 2.4 firefighters per 1,000 persons (State of Tennessee 1998).

3.2.8.3.3 Health Care

A total of 1,525 physicians served the ORR region of influence, with the majority practicing in Knox County (Randolph, Seidman, and Pasko, 1995). The average physician-to-population ratio was 3.2 physicians per 1,000 persons. In 1994, there were 13 hospitals serving the region of influence with a total of 2,833 beds (AHA 1995).

3.2.8.4 Local Transportation

Vehicles access ORR via three state routes. State Route 95 forms an interchange with Interstate 40, and enters the reservation from the south. State Route 58 enters the reservation from the west, and passes just south of the East Tennessee Technology Park. State Route 162 extends from Interstate 75 and Interstate 40 just west of Knoxville, and provides eastern access to ORR (Figure 3–1).

Within ORR, several routes are used to transfer traffic from the state routes to the main plant areas. Bear Creek Road, north of Y–12, flows in an east-west direction and connects Scarboro Road on the east end of the plant with State Road 95 and State Road 58. Bear Creek Road has restricted access around Y–12, and is not a public thoroughfare. Bethel Valley Road, a public roadway, provides access to ORNL, and extends from the east end of ORR at State Road 62 to the west end at State Route 95. Access to the 7900 Area is provided by secondary roads with controlled access: First Street, which runs north-south from Bethel Valley Road, and Mountain Valley Road, which runs east-west and passes the 7900 Area entry road (McGee 2000).

Two main branches provide rail service for ORR. The CSX Transportation line at Elza (just east of Oak Ridge) serves Y–12 and the Office of Science and Technological Information in east Oak Ridge. The Norfolk and Southern main line from Blair provides easy access to the East Tennessee Technology Park. The Clinch River has a barge facility located on the west end of ORR near the East Tennessee Technology Park and is occasionally used to receive shipments that are too large or too heavy to be transported by rail or truck. McGhee Tyson Airport, 37 kilometers (23 miles) from ORR, is the nearest airport serving the region, with major carriers providing passenger and cargo service. A private airport, Atomic Airport, Inc., is the closest air transportation facility to Oak Ridge. Oak Ridge has a part-time public transportation system (DOE 1996b).

3.2.9 Existing Human Health Risk

Existing human health risk issues include the determination of potentially adverse effects on human health that result from acute and chronic exposures to ionizing radiation and hazardous chemicals.

3.2.9.1 Radiation Exposure and Risk

3.2.9.1.1 General Site Description

Major sources and levels of background radiation exposure to individuals in the vicinity of ORR are shown in **Table 3–5**. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population, in terms of person-rem, changes as the population size changes. Background radiation doses are unrelated to ORR operations.

Table 3–5 Sources of Radiation Exposure to Individuals in the ORR Vicinity Unrelated to ORR Operations

Source	Effective Dose Equivalent (millirem per year)
Natural background radiation[a]	
Cosmic radiation	36
External terrestrial radiation	28
Internal terrestrial/cosmogenic radiation	40
Radon in homes (inhaled)	200
Other background radiation[b]	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	Less than 1
Air travel	1
Consumer and industrial products	10
Total	370

a. Hamilton et al. 1999.
b. NCRP 1987.
Note: Value of radon is an average for the United States.

Releases of radionuclides to the environment from ORR operations provide another source of radiation exposure to individuals in the vicinity of ORR. Types and quantities of radionuclides released from ORR operations in 1998 are listed in the *Oak Ridge Reservation Annual Site Environmental Report for 1998* (Hamilton et al. 1999). The doses to the public resulting from these releases are presented in **Table 3–6**. These doses fall within radiological limits per DOE Order 5400.5 and are much lower than those of background radiation.

Table 3–6 Radiation Doses to the Public from ORR 1998 Normal Operations (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard**[a]	**Actual**	**Standard**[a]	**Actual**	**Standard**[a]	**Actual**
Maximally exposed individual (millirem)	10	0.73	4	2.6[b]	100	4.4[c]
Population within 80 kilometers (person-rem)[d]	None	12.3	None	48	100	60.3
Average individual within 80 kilometers (millirem)[e]	None	0.014	None	0.055	None	0.069

a. The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10-millirem-per-year limit from airborne emissions is required by the Clean Air Act, and the 4-millirem-per-year limit is required by the Safe Drinking Water Act; for this NI PEIS, the 4-millirem-per-year value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. The total dose of 100 millirem per year is the limit from all pathways combined. The 100-person-rem value for the population is given in proposed 10 CFR Part 834, as published in 58 FR 16268. If the potential total dose exceeds the 100-person-rem value, it is required that the contractor operating the facility notify DOE.
b. These doses are mainly from drinking water (approximately 0.35 millirem) and eating fish from the Clinch River section of Poplar Creek.
c. This total dose includes a conservative value of 1 millirem per year from direct radiation exposure to a cesium field near the Clinch River.
d. Based on a population of about 880,000 in 1997.
e. Obtained by dividing the population dose by the number of people living within 80 kilometers (50 miles) of the site.
Source: Hamilton et al. 1999.

Using a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Appendix H), the risk of a latent cancer fatality to the maximally exposed member of the public due to radiological releases from ORR operations in 1998 is estimated to be 2.2×10^{-6}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of ORR operations is approximately 2 in 1 million, as it takes several to many years from the time of radiation exposure for a cancer to manifest itself.

According to the same risk estimator, 0.030 excess latent cancer fatality is projected in the population living within 80 kilometers (50 miles) of ORR from normal operations in 1998. To place this number in perspective, it may be compared with the number of cancer fatalities expected in the same population from all causes. The 1997 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Famighetti 1998:964). Based on this mortality rate, the number of cancer fatalities expected during 1997 from all causes in the population living within 80 kilometers (50 miles) of ORR was 1,760, which was much higher than the 0.030 latent cancer fatality estimated from ORR operations in 1997.

ORR workers receive the same doses as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. The average dose to the individual worker and the cumulative dose to all workers at ORR from operations in 1997 are presented in **Table 3–7**. These doses fall within the radiological regulatory limits of 10 CFR Part 835. According to a risk estimator of 400 cancer fatalities per 1 million person-rem among workers (Appendix H), the number of projected latent cancer fatalities among ORR workers from normal operations in 1997 is 0.031.

Table 3–7 Radiation Doses to Workers from Normal ORR Operations in 1997 (Total Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average radiation worker (millirem)	None[b]	48
Total workers (person-rem)[c]	None	78

a. The radiological limit for an individual worker is 5,000 millirem per year. However, DOE's goal is to maintain radiological exposure as low as is reasonably achievable. It has therefore established the Administrative Control Level of 2,000 millirem per year; the site must make reasonable attempts to maintain individual worker doses below this level.

b. No standard is specified for an "average radiation worker;" however, the maximum dose that this worker may receive is limited to that given in footnote "a."

c. Based on a worker population of 1,614 with measurable doses in 1997.

Source: 10 CFR Section 835.202, DOE 1999d.

A more detailed presentation on the radiation environment, including background exposures and radiological releases and doses, is presented in the *Oak Ridge Reservation Annual Site Environmental Report for 1998* (Hamilton et al. 1999). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (on and off site) are also presented in the report.

3.2.9.1.2 Location of Proposed Activities

External radiation doses and concentrations of gross alpha and beta in air have been measured in the vicinity of the HFIR/REDC area. In 1998, the concentrations of gross alpha and beta were about 1.5×10^{-14} microcuries per milliliter and 2.9×10^{-14} microcuries per milliliter, respectively; at the offsite control location, the gross alpha and beta concentrations were 2.4×10^{-15} and 7.0×10^{-15}, respectively. No concentrations of plutonium in this area were detected in 1998 (Hamilton et al. 1999).

3.2.9.2 Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media through which people may come in contact with hazardous chemicals (e.g., surface water during swimming, soil through direct contact, or food). Hazardous chemicals can cause cancer and other adverse health effects.

Carcinogenic Effects. Health effects in this case are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. This could be incremental or excess individual lifetime cancer risk.

Noncarcinogenic Effects. Health effects in this case are determined by the ratio between the calculated, or measured concentration of the chemical in the air and the reference concentration or dose. This ratio is known as the Hazard Quotient. Hazard Quotients for noncarcinogens are summed to obtain the Hazard Index. If the Hazard Index is less than 1, no adverse health effects would be expected.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., air emissions and NPDES permit requirements) contribute to minimizing health impacts on the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts on the public may occur by inhaling air containing hazardous chemicals released to the atmosphere during normal ORR operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are lower than those via the inhalation pathway.

Baseline concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed from normal operations at ORR. These concentrations are in compliance with applicable guidelines and regulations. Information on estimating the health impacts of hazardous chemicals is presented in Appendix H.

Exposure pathways to ORR workers during normal operation may include inhaling contaminants in the workplace atmosphere and through direct contact with hazardous materials. The potential for health impacts varies among facilities and workers, and available information is insufficient for a meaningful estimate of impacts. However, workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, substitution, and engineering and management controls. ORR workers are also protected by adherence to Occupational Safety and Health Administration (OSHA) and EPA standards that limit the workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals used in the operational processes ensure that these standards are not exceeded. Additionally, DOE requires that conditions in the workplace be as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm.

3.2.9.3 Health Effects Studies

Two epidemiologic studies were conducted to determine whether ORR contributed to any excess cancers in communities surrounding the facility. One study found no excess cancer mortality in the population living in counties surrounding ORR, when compared to the control populations in other nearby counties and elsewhere in the United States. The other study found slight excess cancer incidences of several types in the counties near ORR, but less than the number of expected cancers incidences for other types of cancers.

A pilot study on mercury contamination conducted by the Tennessee Department of Health and Environment showed no difference in urine or hair mercury levels between individuals with potentially high mercury exposures compared to those with little potential for exposure. However, soil analysis showed that the mercury in soil is inorganic, which decreases the likelihood of a toxic accumlation in living tissue (bioaccumulation) and adverse health effects. Studies are continuing on the long-term effects of exposure to mercury and other hazardous chemicals.

More epidemiologic studies have been conducted to assess health effects on the population working at ORR than any other site reviewed for this document. Excess cancer mortalities have been reported and linked to specific job categories, age, and length of employment, as well as to the levels of exposure to radiation.

For a more detailed description of the epidemiologic studies, refer to Appendix M.4.6 of the *Storage and Disposition PEIS* (DOE 1996b:M-235 to M-242).

3.2.9.4 Accident History

There have been no safety-related accidents causing significant injury or harm to workers, or posing any sort of harm to the offsite public, at HFIR or REDC during their operational lifetimes (DOE 1999e).

In addition, there have been no accidents with a measurable impact on offsite population during nearly 50 years of Y–12 operations at ORR. The most noteworthy accident in Y–12's history was a 1958 criticality accident, which resulted in temporary radiation sickness for a few ORR employees. In 1989, there was a one-time accidental release of xylene into the ORR sewer system with no offsite impacts. Accidental releases of anhydrous hydrogen fluoride occurred in 1986, 1988, and 1992, with little onsite and negligible offsite impacts. The hydrogen fluoride system where these accidents occurred is being modified to reduce the probability of future releases, and to minimize the potential consequences if a release does occur.

3.2.9.5 Emergency Preparedness

Each DOE site has established an emergency management program that would be activated in the event of an incident that threatens the health and safety of workers and the public. This program has been developed and maintained to ensure adequate response to most incident conditions, and to provide response efforts for incidents not specifically considered. The emergency management program includes emergency planning, preparedness, and response.

DOE has overall responsibility for emergency planning and operations at ORR. However, DOE has delegated primary authority for event response to the operating contractor. Although the contractor's primary response responsibility is on site, the contractor does provide offsite assistance, if requested, under the terms of existing mutual aid agreements. If a hazardous materials event with offsite impacts occurs at a DOE facility, elected officials and local governments are responsible for the state's response efforts. The Tennessee Emergency Management Agency is the established agency responsible for coordinating state emergency services. When a hazardous materials event occurring at DOE facilities is beyond the capability of local government and assistance is requested, the Tennessee Emergency Management Agency Director may direct state agencies to provide assistance to the local governments. To accomplish this task and ensure prompt initiation of emergency response actions, the Director may cause the state Emergency Operations Center and Field Coordination Center to be activated. City or county officials may activate local Emergency Operations Centers in accordance with existing emergency plans.

DOE has specified actions to be taken at all DOE sites to implement lessons learned from the emergency response to an accidental explosion at Hanford in May 1997.

3.2.10 Environmental Justice

Under Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, Federal agencies are responsible for identifying and addressing the possibility of disproportionately high and adverse health, economic, and environmental impacts of programs and activities on minority and low-income populations in potentially affected areas. Minority populations refer to persons of any race self-designated as Asian, Black, Native American, or Hispanic. Low-income populations refer to households with incomes below the Federal poverty thresholds. In the case of ORR, the potentially affected area includes parts of Tennessee, North Carolina, and Kentucky.

The potentially affected area surrounding ORNL is defined by a circle with an 80-kilometer (50-mile) radius centered at HFIR/REDC (latitude 35° 55'8" N, longitude 84° 18'14" W). The total population residing within that area in 1990 was 881,987, while the minority population was 6.1 percent of that (DOC 1992). In 1990, approximately one-fourth of the total national population was comprised of persons self-designated as members of a minority group. Percentage minority populations residing in the States of Tennessee, North Carolina, and Kentucky were 17.4 percent, 25.0 percent, and 8.3 percent, respectively.

At the time of the 1990 census, Blacks were the largest minority group within the potentially affected area, constituting 4.7 percent of the total population. Asians made up 0.5 percent, Hispanics, 0.5 percent, and Native Americans made up 0.4 percent of the population (DOC 1992).

In 1990, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 137,708 persons (16 percent of the total population) residing within the potentially affected area around ORNL reported incomes below that threshold (DOC 1992). Data obtained during the 1990 census show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold. Percentages for those below the poverty threshold in Tennessee, North Carolina, and Kentucky were 19.0 percent, 13.1 percent, and 15.7 percent, respectively.

A more detailed description of the environmental justice analysis is given in Appendix K.

3.2.11 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE activities. The waste is managed using appropriate treatment, storage and disposal technologies and in compliance with all Federal and state statutes and DOE orders. Disposal and management of previously generated ORR waste, known as legacy waste, is the responsibility of DOE's environmental management contractor, which is working to repackage, remove, and dispose of the existing legacy waste and newly generated wastes. The strategy is to dispose of current inventories of all waste types and close many of the existing storage facilities. The long-range strategy is to rely on a combination of onsite and offsite facilities to dispose of newly generated waste.

3.2.11.1 Waste Inventories and Activities

ORR manages the following types of waste: transuranic, mixed transuranic, low-level radioactive, mixed low-level radioactive, hazardous, and nonhazardous. Waste generation rates and the inventory of stored waste from activities at ORR are provided in **Table 3–8**. Because ORR does not generate or manage high-level radioactive waste and it would not be generated by the proposed plutonium-238 production, new medical and industrial isotope production, or new nuclear research and development activities at ORR, high-level radioactive waste is not included in this table or discussed any further in this section. ORR waste management capabilities are summarized in **Table 3–9**. More detailed descriptions of the waste management system capabilities at ORR are included in the *Storage and Disposition PEIS* (DOE 1996b:3-219, E-63).

DOE is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at ORR. DOE is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for

Table 3–8 Waste Generation Rates and Inventories at ORR and ORNL

Waste Type	Generation Rates (cubic meters per year)		Inventory (cubic meters)	
	ORR[a]	ORNL	ORR[a]	ORNL
Transuranic				
Contact handled	12	12	1,000	1,000
Remotely handled	10	10	550	550
Remotely handled sludge (tank waste)	1.5	1.5	900	900
Low-level radioactive				
Liquid[b]	12,500 (total)	1,200	20,000[c] (total)	1,600
Solid		2,400		3,614
Process waste	283,900	283,900	0[d]	0[d]
Mixed low-level radioactive				
Liquid	(e)	(e)	(e)	(e)
Solid	1,600	475	26,000	3,000
Hazardous	36,000 kg/yr	—	1,689	–
Nonhazardous				
Liquid	269,000	60,600	NA[f]	NA[f]
Solid	29,500	5,700	NA[f]	NA[f]

a. Represents entire waste generated or managed at ORR, including ORNL.
b. Liquid low-level radioactive waste is processed through an evaporator for volume reduction, and the evaporator bottoms are stored as a concentrated solution.
c. Excludes waste from DOE environmental restoration activities.
d. This inventory is zero because the process waste is treated and discharged.
e. Mixed liquid low-level radioactive waste is reported as low-level radioactive waste. Certain contents are mixed-permit-by-rule.
f. Generally, this waste is not held in long-term storage.

Note: To convert from cubic meters to cubic yards, multiply by 1.308. To convert from kilograms to pounds, multiply by 2.2.
Key: kg/yr, kilograms per year; NA, not applicable.
Source: Brunson 1999; DOE 1997a; Wham 1999.

achieving compliance with applicable requirements and financial penalties for nonachievement of agreed-upon milestones.

EPA placed ORR on the National Priorities List, which identifies sites for possible long-term remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), on November 21, 1989. DOE, EPA Region IV, and the Tennessee Department of Environment and Conservation completed a Federal Facility Agreement, effective January 1, 1992. This agreement coordinates ORR inactive site assessment and remedial actions. Portions of the Federal Facility Agreement are applicable to operating waste management systems. Existing actions are conducted under the Resource Conservation and Recovery Act (RCRA) and applicable state laws which minimize duplication, expedite response actions, and achieve a comprehensive remediation of the site. More information on regulatory requirements for waste disposal is provided in Chapter 5.

3.2.11.2 Transuranic Waste

Although ORNL is the only current generator of transuranic wastes on ORR, other sites at ORR have produced small quantities of transuranic wastes in the past and are likely to do so again during decontamination and decommissioning activities. Transuranic waste includes contact-handled transuranic and remotely handled transuranic. Normally, contact-handled transuranic waste consists primarily of miscellaneous waste from

Table 3–9 Waste Management Capabilities at ORR

Facility Name/ Description	Capacity	Status	Applicable Waste Type					
			TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
Y–12: Treatment Facility (cubic meters per year except as otherwise specified)								
West End Treatment Facility, Building 9616-7	10,221	Online			X	X	X	X
Central Pollution Control Facility	10,200	Online			X	X	X	
Acid Neutralization and Recovery Facility, Building 9818	2,100	Online				X		
Uranium Chip Oxidizer Facility	Classified	Online			X			
Cyanide Treatment Facility	185	Online				X	X	
Plating Rinsewater Treatment Facility (Building 9623)	30,283	Online					X	X
Steam Plant Wastewater Facility	177,914	Online					X	X
Oak Ridge Sewage Treatment Plant (offsite) cubic meters per day	5,300	Online						X
Building 9720-25 Baler Facility	41,700	Online						X
Waste Coolant Processing Facility, Building 9983-78	1,363	Online			X	X		
Organic Handling Unit, Building 9815 (gallons per day)	500	Online			X	X		
Uranium Recovery Operations, Building 9212	2,100	Online				X		
Y–12: Storage Facility (cubic meters)								
Aboveground Storage Pads (Building 9830-2 through 7)	7,130	Online			X			
Buildings 9206 and 9212, Container Storage Areas	30	Online			X	X		
Building 9720-12, Container Storage Facility	123	Online			X	X		
Contaminated Scrap Metal Storage Yard	4,740	Online			X			X
Cyanide Treatment Facility (Building 9201-5N)	8	Online				X	X	
Liquid Organic Waste Storage Facility (Building 9720-45, OD-10)	198	Online				X	X	
Liquid Storage Facility (Building 9416-35)	416	Online				X	X	
PCB and RCRA Hazardous Drum Storage Facility (Building 9720-9)	1,404	Online				X	X	
RCRA and PCB Container Storage Area (Building 9720-58)	1,130	Online				X	X	
RCRA Staging and Storage Facility (Building 9720-31)	170	Online				X	X	
RCRA Storage Facility (Building 9811-1, OD-8)	723	Online			X	X	X	
Waste Oil/Solvent Storage Facility (Building 9811-8, OD-9)	790	Online			X	X	X	
Tank Farm, Building 9212	151	Planned				X		

Facility Name/ Description	Capacity	Status	Applicable Waste Type					
			TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
Container Storage Area/Production Waste Storage Facility, Building 9720-32	2,335	Online					X	
Low Level Waste Storage Pad, Building 9720-44	Not specified	Online			X			
Classified Waste (Container) Storage Area, Building 9720-59	1,090	Online			X	X		
Organic Handling Unit, Building 9815	8	Online					X	
Depleted Uranium Storage Vaults I and II (Building 9825-1 and 2 oxide vaults) and Building 9809	1,020	Online			X			
West Tank Farm	10,600	Online			X	X		
Y–12: Disposal Facility (cubic meters)								
Industrial and Sanitary Landfill V[a]	1,100,000[a]	Online						X
Construction Demolition Landfill VI[a]	119,000[a]	Online						X
Oak Ridge National Laboratory: Treatment Facility (cubic meters per year)								
Process Waste Treatment Plant	280,000	Online			X			
Melton Valley Low-Level Waste Immobilization Facility and Liquid Low-Level Waste Evaporation Facility	110,000	Online			X			
Waste Compaction Facility (Building 7831)	11,300	Online			X			
Sanitary Waste Water Treatment Facility (design capacity)	414,000	Online						X
Nonradiological Wastewater Treatment Facility	1,510,000	Online					X	
Oak Ridge National Laboratory: Storage Facility (cubic meters)								
Buildings 7826, 7834, 7842, 7878, 7879, and 7934	1,760	Online	X					
Bunker and Earthen Trenches (SWSA 5N Building 7855 and SWSA7 Building 7883)	1085	Online	X		X			
Liquid Low-Level Radioactive Waste Systems	3,230	Online			X			
Onsite tanks	7,850	Online			X			
Buildings 7507W, 7654, 7823, and Tank 7830a	393	Online				X		
Hazardous Waste Storage Facility (Buildings 7507 and 7652) and Buildings 7651 and 7653	130	Online					X	
Interim Waste Management Facility (IWMF)	5,365 (1,730)[b]	Online			X			
Oak Ridge National Laboratory: Disposal Facility (cubic meters)								
Shared Landfills V and VI	(Refer to footnote a)	Online						X

Facility Name/ Description	Capacity	Status	Applicable Waste Type: TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
East Tennessee Technology Park: Treatment Facility (cubic meters per year)								
TSCA Incinerator (Building K-1435)	15,700	Online			X	X		
Central Neutralization Facility (permitted operating capacity)	221,000	Online				X		
Sewage Treatment Plant (Building K-1203)	829,000	Online						X
East Tennessee Technology Park: Storage Facility (cubic meters per year)								
Building K-25, outside areas, K-1313 A and K-33	44,000	Online			X			
Current permitted container (solids/sludges/liquid wastes) and tank (liquids) storage capacity	97,000	Online				X		
Total current permitted waste pile unit storage capacity	120,000	Online				X		
Stockpiled at scrap yard	Not specified	Online						X
East Tennessee Technology Park: Disposal Facility (cubic meters per year)								
Shared Landfills V and VI	(Refer to footnote a)	Online						X

a. Industrial and Sanitary Landfill V and Construction Demolition Landfill VI serve all three sites for disposal of solid nonhazardous waste. Their disposal capacities are 1,100,000 cubic meters and 119,000 cubic meters, respectively.
b. Available as of June 1999.
Note: To convert from cubic meters to cubic yards, multiply by 1.308.
Key: Haz, hazardous; LLW, low-level waste; PCB, polychlorinated biphenyl; RCRA, Resource Conservation and Recovery Act; TRU, transuranic; TSCA, Toxic Substances Control Act.
Source: DOE 1996b:3-200–3-225; PAI Corporation 1996; Rathke 2000; Wham 1999.

glovebox operations (e.g., paper, glassware, plastic, shoe covers, and wipes), discarded high efficiency particulate air filters, and discarded equipment (e.g., gloveboxes and processing equipment). Contact-handled transuranic waste has a surface dose rate that does not exceed 200 millirem per hour. Generally, contact-handled transuranic waste is contained within polyethylene bags inside 208-liter (55-gallon) stainless steel drums. Metal paint cans, plastic buckets, and other similar containers are also used to package waste inside the drums.

Remotely handled transuranic waste consists primarily of miscellaneous hot cell waste (e.g., paper, glass, plastic tubing, and wipes), high efficiency particulate air filters, and discarded equipment (e.g., processing racks, vacuum pumps, and furnaces). Unshielded remotely handled transuranic waste packages typically have radiation levels that measure between 10 and 2,000 rem per hour; however, most are below 100 rem per hour. Shielding generally reduces the levels at the surface of the container to approximately 1 rem per hour. Remotely handled transuranic waste contains activation and fission products that decay and emit neutron and gamma radiation on the surface of the packaging that exceeds 200 millirem per hour. The activation materials are transuranium radionuclides ranging from plutonium-238 to californium-252, but are usually dominated by curium-244 which contributes to the neutron dose from spontaneous fission and alpha-n reactions. The alpha-n reactions contribute to the external dose rate measured at the surface of a container for both the contact-handled transuranic and remotely handled transuranic solid waste.

Remotely handled transuranic wastes are usually contained in concrete casks (1.4 meters [4.5 feet] in diameter by 2.3 meters [7.5 feet] high). The wall thicknesses of the casks are currently either 15 centimeters

(6 inches) or 30.5 centimeters (12 inches) thick, depending on the radiation level of the contents. A large polyethylene bag is placed inside the cask for additional contamination control prior to use. Most remotely handled transuranic wastes inside the concrete casks are also contained inside polyethylene bags. Smaller waste packages such as 11-liter (2.9-gallon) plastic buckets, 3.7-liter (0.98-gallon) paint cans, and 18.9-liter (5.0-gallon) metal cans are packaged within the polyethylene bags. Fiber drums and carbon and steel drums have also been used to package waste inside the concrete cask. Intermediate-sized items that will not fit in the previously mentioned packages are generally placed in vinyl bags, then placed inside the lined waste cask. Large cask items may be placed directly in the cask.

As of January 1999, approximately 1,000 cubic meters (1,310 cubic yards) of contact-handled transuranic waste was in retrievable drum storage in the Bunker and Earthen Trenches. The amount of remotely handled transuranic waste was about 550 cubic meters (719 cubic yards) (64 FR 4079). Current activities center around certification of contact-handled waste, planning and designing of a repackaging and certification facility for remote-handled wastes, and planning for shipment of waste to the Waste Isolation Pilot Plant (WIPP) or another suitable geologic repository for disposal.

3.2.11.3 Low-Level Radioactive Waste

Solid low-level radioactive waste is compactible radioactive waste such as paper, plastic, cloth, glass, cardboard, filters, floor sweepings, styrofoam, clothing, ceiling tile, and miscellaneous radioactively-contaminated trash. The waste may include up to 20 percent lightweight or non-smeltable metal items. The solid low-level radioactive waste normally generated at ORNL consists primarily of radioactively-contaminated personnel protection equipment, paper debris, trapping media, and process equipment. The Interim Waste Management Facility at ORNL only accepts low-level radioactive waste generated at ORNL. However, the Interim Waste Management Facility is at two-thirds of capacity, and access to this facility for the proposed plutonium-238 production, new medical and industrial isotope production, or new nuclear reasearch and development activities is not expected. Solid low-level radioactive waste is being stored at the East Tennessee Technology Park and Y–12 for future disposal. Contaminated scrap metal is stored above ground at the K-770 scrap metal facility, the old salvage yard at Y–12, and at ORNL which is being managed by the DOE scrap metal program until further disposal methods are evaluated.

The basic low-level radioactive waste strategy is to:

1. Use the Interim Waste Management Facility for legacy waste until it is filled to capacity.

2. Stage low-level radioactive waste at all sites, with emphasis on storage at the East Tennessee Technology Park until a disposal site is available.

3. Ship waste to the Nevada Test Site, Hanford, or a commercial disposal site as access is approved, and according to site-specific waste acceptance criteria.

3.2.11.4 Mixed Low-Level Radioactive Waste

RCRA mixed low-level radioactive waste is in storage at Y–12, East Tennessee Technology Park, and ORNL. Because prolonged storage of these wastes exceeded the one-year limit imposed by RCRA, ORR entered into a Federal Facility Compliance Agreement for RCRA Land Disposal Restriction wastes with EPA on June 12, 1992. This agreement was terminated with the issuance of the Tennessee Department of Environmental Conservation Commissioner's Order, effective October 1, 1995, which requires DOE to comply with the Site Treatment Plan prepared by ORR. The plan contains milestones and target dates for DOE to characterize and treat its inventory of mixed wastes at ORR. Sludges contaminated with low-level radioactivity are generated by settling and scrubbing operations, and in the past were stored in K-1407-C ponds at the East Tennessee Technology Park.

Sludges have been removed from these ponds and a portion has been fixed in concrete at the K–1419 Sludge Treatment Facility, and stored at the K–33 building. The concreted sludges are being shipped off site for disposal. The raw sludges are stored in the K–1065 building, pending further treatment. Mixed waste sludges are also generated at Y–12 in the treatment of nitrate waste from purification and recycling of uranium and in the treatment of plating shop waste.

The primary facility generator of liquid mixed waste is the K–1435 Toxic Substances Control Act Incinerator from the wet scrubber blowdown. This waste is currently being treated at the Central Neutralization Facility, which provides pH adjustment and chemical precipitation. Treated effluents are discharged through a NPDES outfall. The contaminated sludges are stored as mixed waste at the East Tennessee Technology Park.

The East Tennessee Technology Park Toxic Substances Control Act Incinerator has a design capacity to incinerate 909 kilograms (2,000 pounds) per hour of mixed liquid waste and up to 455 kilograms (1,000 pounds) per hour of solids and sludge (91 kilograms [200 pounds] per hour maximum sludge content). The Toxic Substances Control Act Incinerator is capable of incineration of both Toxic Substances Control Act- and RCRA-mixed wastes. The Toxic Substances Control Act Incinerator capacity utilization for incinerable solids is limited to ORR wastes to support the completion of enforceable milestones required by the ORR Site Treatment Plan. Because of permit limits (Toxic Substances Control Act, RCRA, State of Tennessee), the incinerator is not running at full capacity. In 1994, approximately 2,590 cubic meters (683,000 gallons) of mixed liquid waste was incinerated (DOE 1996b:3-226).

The two major types of mixed waste generated at ORNL are mixed waste oils and scintillation fluids. Mixed waste oils are generated when oils are removed from systems that have operated in radiation environments. Radiation levels in these oils are typically low (less than or equal to 10 millirem per hour). Generally, these wastes consist of vacuum pump oil, axle oil, refrigeration oil, mineral oil, or oil/water mixtures. The principal components of scintillation fluids are toluene and/or xylene, culture medium, and miscellaneous organics. Other mixed wastes generated at ORNL include organic wastes, carcinogenic wastes, mercury-contaminated solid waste, waste solvents, corrosives, poisons, and other process waste. Because of the diversity of the mixed waste generated at ORNL, quantities are usually small.

Uranium wastes contaminated with polychlorinated biphenyl are being stored because of lack of treatment and disposal capacities. DOE and EPA signed a Federal Facility Compliance Agreement, effective December 16, 1996, to bring East Tennessee Technology Park into compliance with Toxic Substances Control Act regulations for use, storage, and disposal of polychlorinated biphenyls. It also addressed the approximately 10,000 pieces of nonradioactive polychlorinated biphenyls-containing dielectric equipment used in the shutdown of diffusion plant operations.

3.2.11.5 Hazardous Waste

RCRA-regulated wastes are generated by ORR in laboratory research, electroplating operations, painting operations, descaling, demineralizer regeneration, and photographic processes. Certain other wastes (e.g., spent photographic processing solutions) are processed on site into a nonhazardous state. Those wastes that are safe to transport, and have been certified as having no radioactivity added, are shipped off site to RCRA-permitted commercial treatment and disposal facilities. Small amounts of reactive chemical explosives that would be dangerous to transport off site, such as aged picric acid, are processed on site in the Chemical Detonation Facility at ORNL.

3.2.11.6 Nonhazardous Waste

Nonhazardous wastes are generated from numerous ORR activities. For example, the steam plant produces nonhazardous sludge. Scrap metals are discarded from maintenance and renovation activities and are recycled when appropriate. Construction and demolition projects produce nonhazardous industrial wastes. Other nonhazardous wastes include paper, plastic, glass, can, cafeteria wastes, and general trash. All nonradioactive medical wastes are autoclaved to render them noninfectious and are sent to the Y–12 Sanitary Landfill. Remedial action projects also produce wastes requiring proper management. The State of Tennessee permitted landfill (Construction Demolition Landfill VI) receives nonhazardous industrial materials such as fly ash and construction debris. Asbestos and general refuse are managed in Industrial and Sanitary Landfill V located at Y–12.

3.2.11.7 Waste Minimization

The DOE Oak Ridge Operations Office has an active waste minimization and pollution prevention program to reduce the total amount of waste generated and disposed of at ORR. This is accomplished by eliminating waste through source reduction or material substitution; recycling potential waste materials that cannot be minimized or eliminated; and treating waste generated to reduce its volume, toxicity, or mobility prior to storage or disposal. Implementing pollution prevention projects reduced the amount of waste generated at ORR in 1998 by approximately 64,900 cubic meters (84,000 cubic yards). Examples of pollution prevention projects completed in 1998 at the Oak Ridge Operations Office include: reducing cleanup/stabilization of low-level radioactive waste by approximately 395 cubic meters (517 cubic yards), mixed low-level radioactive waste by approximately 119 cubic meters (156 cubic yards), and hazardous waste by approximately 83 metric tons (91 tons) by providing incentives in contracts for projects to turn over vacant and decontaminated buildings to the DOE Oak Ridge Operation Office reducing routine operations mixed low-level radioactive waste by approximately 693 cubic meters (906 cubic yards) by selling various scrap metals (including clean and contaminated carbon steel and copper) to an outside vendor for cleaning and recycling; and reducing of transuranic waste generation by less than 1 cubic meter (1.3 cubic yards) per year by replacing three oil-lubricated vacuum pumps with dry pumps, which eliminated the transuranic-contaminated waste oil stream and associated waste (DOE 1999f:56).

3.2.11.8 Waste Management PEIS Records of Decision

The *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (*Waste Management PEIS*) Records of Decision affecting ORR are shown in **Table 3–10** for the waste types analyzed in this NI PEIS. Decisions on the various waste types are being announced in a series of Records of Decision that have been issued on the *Waste Management PEIS*. The transuranic waste Record of Decision was issued on January 20, 1998 (63 FR 3629); the hazardous waste Record of Decision was issued on August 5, 1998 (63 FR 41810); and the low-level radioactive waste and mixed low-level radioactive waste Record of Decision was issued on February 18, 2000 (65 FR 10061). The transuranic waste Record of Decision states that DOE will develop and operate mobile and fixed facilities to characterize and prepare transuranic waste for disposal at WIPP. Each DOE site that has or will generate transuranic waste will, as needed, prepare and store its transuranic waste on site. The hazardous waste Record of Decision states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste, with ORR and Savannah River Site (SRS) continuing to treat some of their own nonwastewater hazardous waste on site in existing facilities, where this is economically favorable. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision states that for the management of low-level radioactive waste, minimal treatment will be performed at all sites, and disposal will continue, to the extent practicable, on site at INEEL, Los Alamos National Laboratory (LANL), ORR, and SRS. In addition, Hanford and the Nevada Test Site will

Table 3–10 Waste Management PEIS Records of Decision Affecting ORR

Waste Type	Preferred Action
Transuranic and mixed transuranic	DOE has decided that ORR should prepare and store its transuranic waste on site pending disposal at WIPP[a] or another suitable geologic repository.
Low-level radioactive	DOE has decided to treat ORR's liquid low-level radioactive waste on site.[b] Separate from the *Waste Management PEIS*, DOE prefers offsite management of ORR's solid low-level radioactive waste after temporary onsite storage.
Mixed low-level radioactive	DOE has decided to regionalize treatment of mixed low-level radioactive waste at ORR.[b] This includes the onsite treatment of ORR's waste and could include treatment of some mixed low-level radioactive waste generated at other sites.
Hazardous	DOE has decided to use commercial and onsite ORR facilities for treatment of ORR nonwastewater hazardous waste. DOE will also continue to use onsite facilities for wastewater hazardous waste.[c]

a. From the Record of Decision for transuranic waste (63 FR 3629).
b. From the Record of Decision for low-level radioactive and mixed low-level radioactive waste (65 FR 10061).
c. From the Record of Decision for hazardous waste (63 FR 41810).
Source: 63 FR 3629; 65 FR 10061; 63 FR 41810.

be available to all DOE sites for low-level radioactive waste disposal. Mixed low-level radioactive waste will be treated at Hanford, INEEL, ORR, and SRS and disposed of at Hanford and the Nevada Test Site. More detailed information concerning DOE's preferred alternatives for the future configuration of waste management facilities at ORR is presented in the *Waste Management PEIS* and the transuranic waste, hazardous waste, and low-level radioactive and mixed low-level radioactive waste Records of Decision.

3.3 IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY

INEEL is on 230,700 hectares (570,000 acres) in southeastern Idaho and is 55 kilometers (34 miles) west of Idaho Falls, 61 kilometers (38 miles) northwest of Blackfoot, and 35 kilometers (22 miles) east of Arco. INEEL is owned by the Federal Government and administered, managed, and controlled by DOE. It is primarily within Butte County, but portions of the site are also in Bingham, Jefferson, Bonneville, and Clark counties. The site is roughly equidistant from Salt Lake City, Utah, and Boise, Idaho.

There are approximately 450 buildings and 2,000 support structures at INEEL, with more than 279,000 square meters (3,000,000 square feet) of floor space in varying conditions of utility. INEEL has approximately 25,100 square meters (270,000 square feet) of covered warehouse space and an additional 18,600 square meters (200,000 square feet) of fenced yard space. The total area of the various machine shops is 3,035 square meters (32,665 square feet).

Fifty-two research and test reactors have been designed and deployed at INEEL over the years to test reactor systems, develop fuel and target designs and test the overall safety of reactor systems. In addition to nuclear reactor research, other INEEL facilities are operated to support reactor operations. These facilities include high-level radioactive and low-level radioactive waste processing and storage sites; hot cells; nuclear materials storage vaults; analytical laboratories; machine shops; laundry, railroad, and administrative facilities. Other activities include management of one of DOE’s largest storage sites for low-level radioactive waste, transuranic waste, and spent nuclear fuel (both highly enriched and low-enriched uranium).

3.3.1 Land Resources

Land resources include land use and visual resources. Each of these resource areas is described for the site as a whole, as well as for the locations of the proposed activities.

3.3.1.1 Land Use

Land may be characterized by its potential for the location of human activities (land use). Natural resource attributes and other environmental characteristics could make a site more suitable for some land uses than for others. Changes in land use may have both beneficial and adverse effects on other resources such as ecological, cultural, geological, aquatic, and atmospheric.

3.3.1.1.1 General Site Description

The Federal Government, the State of Idaho, and private parties own lands surrounding INEEL. Regional land uses include grazing, wildlife management, mineral and energy production, recreation, and crop production. Approximately 60 percent of the surrounding area is used by sheep and cattle for grazing. Small communities and towns near the INEEL boundaries include Mud Lake to the east; Arco, Butte City, and Howe to the west; and Atomic City to the south. Two National Natural Landmarks border INEEL: Big Southern Butte (2.4 kilometers [1.5 miles] south) and Hell's Half Acre (2.6 kilometers [1.6 miles] southeast). A portion of Hell's Half Acre National Natural Landmark is designated as a Wilderness Study Area. The Black Canyon Wilderness Study Area is also adjacent to INEEL.

Land use categories at INEEL include facility operations, grazing, general open space, and infrastructure such as roads. Generalized land uses at INEEL and vicinity are shown in **Figure 3–3**. Facility operations include industrial and support operations associated with energy research and waste management activities. Land is also used for recreation and environmental research associated with the designation of INEEL as a National

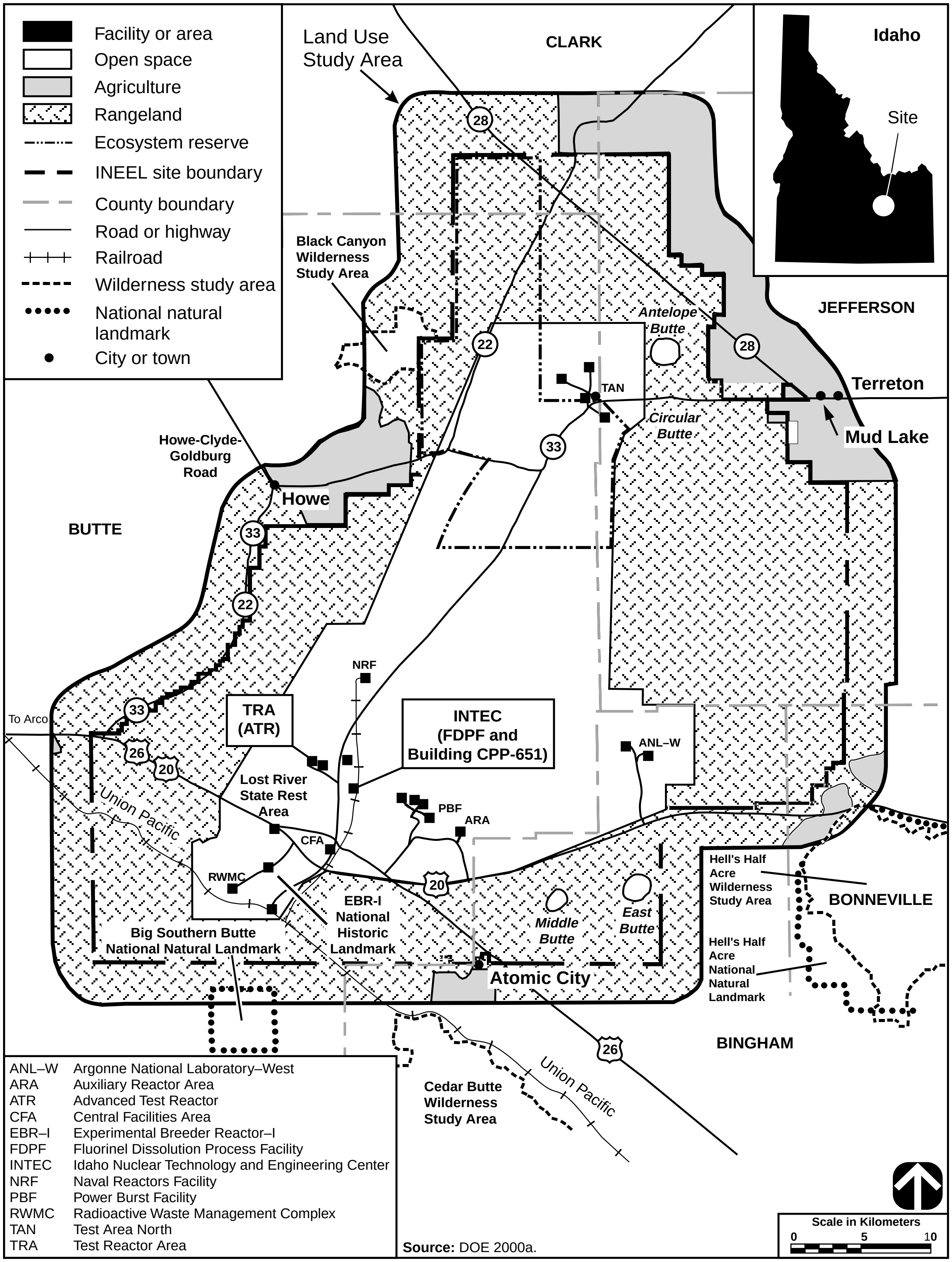

Figure 3–3 Generalized Land Use at Idaho National Engineering and Environmental Laboratory and Vicinity

Environmental Research Park. Much of INEEL is open space that has not been designated for specific use. Some of this space serves as a buffer zone between INEEL facilities and other land uses. Recently, 29,950 hectares (74,000 acres) of open space in the north central portion of the site has been designated as the INEEL Sagebrush Steppe Ecosystem Reserve (DOE 1999g). This area represents one of the last sagebrush steppe ecosystems in the United States and provides a home for a number of rare and sensitive species of plants and animals. Approximately 2 percent of the total INEEL site area (4,600 hectares [11,400 acres]) is used for facilities and operations. Facilities are sited within a central core area of about 93,100 hectares (230,000 acres) (Figure 3–3). Public access to most facilities is restricted. DOE land use plans and policies applicable to INEEL are discussed in the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995a:vol. 2, part A, 4.2-1–4.2-4).

All county plans and policies encourage development adjacent to previously developed areas to minimize the need for infrastructure improvements and to avoid urban sprawl. Because INEEL is remote from most developed areas, its lands and adjacent areas are not likely to experience residential and commercial development, and no new development is planned near the site. Recreational and agricultural uses, however, are expected to increase in the surrounding area in response to greater demand for recreational areas and the conversion of rangeland to cropland (DOE 1999e:3-82).

The Fort Bridger Treaty of July 3, 1868, secured the Fort Hall Reservation as the permanent homeland of the Shoshone-Bannock Peoples. According to the treaty, tribal members reserved rights to hunting, fishing, and gathering on surrounding unoccupied lands of the United States. While INEEL is considered occupied land, it was recognized that certain areas on the INEEL site have significant cultural and religious significance to the tribes. A *1994 Memorandum of Agreement with the Shoshone-Bannock Tribes* (DOE 1994) provides tribal members access to the Middle Butte to perform sacred or religious ceremonies or other educational or cultural activities.

3.3.1.1.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

Land within Idaho Nuclear Technology and Engineering Center (INTEC) is highly disturbed, and is used to store spent nuclear fuel and radioactive wastes, treat radioactive wastes, and develop waste management technologies. The area includes about 85 hectares (210 acres) within the perimeter fence and an additional 22 hectares (54 acres) outside the fence (DOE 1997b:31, 95–111). A number of wastewater and percolation ponds are also present on the site. INTEC is 12 kilometers (7.5 miles) north of the site boundary, and 0.8 kilometer (0.5 mile) southeast of the Big Lost River. Facilities at INTEC include spent fuel storage and processing areas, a waste solidification facility and related high-level waste storage facilities, remote analytical laboratories, and a coal-fired steam-generating plant that is in standby.

TEST REACTOR AREA

The Test Reactor Area is in the southwestern portion of INEEL (Figure 3–3). Land in the Test Reactor Area is currently disturbed, and is designated for reactor operations. The area includes about 15 hectares (37 acres) within the security fence, plus several sewage and waste ponds outside of the fence. The Test Reactor Area is about 11 kilometers (6.8 miles) southeast of the nearest site boundary and about 2.6 kilometers (1.6 miles) northwest of the Big Lost River. The Materials Test Reactor and Engineering Test Reactor (both shut down), the Test Reactor Area Hot Cells, and ATR, which achieved initial criticality in 1967, are in the Test Reactor Area. In addition, numerous support facilities (i.e., storage tanks, maintenance buildings, warehouses), laboratories, and sanitary and radioactive waste treatment facilities are in the area (DOE 1997b:32, 189–201).

3.3.1.2 Visual Resources

Visual resources are natural and human-created features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape.

3.3.1.2.1 General Site Description

The Bitterroot, Lemhi, and Lost River mountain ranges border INEEL on the north and west. Volcanic buttes near the southern boundary of INEEL can be seen from most locations on the site. INEEL generally consists of open desert land predominantly covered by big sagebrush and grasslands. Pasture and farmland border much of the site.

Ten facility areas are on the INEEL site. Although INEEL has a comprehensive facility and land use plan (DOE 1997b), no specific visual resource standards have been established. INEEL facilities have the appearance of low-density commercial/industrial complexes widely dispersed throughout the site. Structure heights generally range from 3 to 30 meters (10 to 100 feet); a few stacks and towers reach 76 meters (250 feet). Although many INEEL facilities are visible from highways, most facilities are more than 0.8 kilometer (0.5 mile) from public roads. The operational areas are well defined at night by the security lights.

Lands adjacent to INEEL, under Bureau of Land Management jurisdiction, are designated as Visual Resource Management Class II areas. Lands within the INEEL site are designated as Visual Resource Management Class II and III. Management activities within these classes may be seen but should not dominate the review (DOI 1986). The Black Canyon Wilderness Study Area, adjacent to INEEL, is under consideration by Bureau of Land Management for Wilderness Area designation, approval of which would result in an upgrade of its Visual Resource Management rating from Class II to Class I. The Hell's Half Acre Wilderness Study Area is 2.6 kilometers (1.6 miles) southeast of INEEL's eastern boundary. This area, famous for its lava flow and hiking trails, is managed by the Bureau of Land Management. The Craters of the Moon Wilderness Area is about 20 kilometers (12 miles) southwest of INEEL's western boundary.

3.3.1.2.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

While the Fuel Processing Facility is the largest building at INTEC, the tallest structure is the main stack, which is 76 meters (250 feet) tall. The Visual Resource Management rating of INTEC is Class IV, which means management activities dominate the view and are the focus of the viewers attention. INTEC is visible in the middle ground from State Highways 20 and 26, with Saddle Mountain in the background. Natural features of visual interest within a 40-kilometer (25-mile) radius include Big Lost River at 0.8 kilometer (0.5 mile), Middle Butte at 18 kilometers (11 miles), Big Southern Butte National Natural Landmark at 20 kilometers (11 miles), East Butte at 23 kilometers (14 miles), Hell's Half Acre Wilderness Study Area at 33 kilometers (21 miles), and Saddle Mountain at 40 kilometers (25 miles).

TEST REACTOR AREA

The tallest structure at ATR within the Test Reactor Area is the main stack, which can be seen from Highways 20, 26, and 22. Developed areas within the Test Reactor Area are consistent with a Visual Resource Management Class IV rating. Natural features of visual interest within a 40-kilometer (25-mile) radius include

Big Lost River at 2.6 kilometers (1.6 miles), Middle Butte at 20 kilometers (12 miles), Big Southern Butte National Natural Landmark at 18 kilometers (11 miles), East Butte at 23 kilometers (14 miles), Hell's Half Acre Wilderness Study area at 35 kilometers (22 miles), and Saddle Mountain at 40 kilometers (25 miles).

3.3.2 Noise

Noise is unwanted sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities or diminish the quality of the environment.

3.3.2.1 General Site Description

Major noise emission sources within INEEL include various industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). Most INEEL industrial facilities are far enough from the site boundary that noise levels at the boundary from these sources are not measurable, or are barely distinguishable from background levels (DOE 1996b:3-112).

Existing INEEL-related noises of public significance are from the transportation of people and materials to and from the site and in-town facilities via buses, trucks, private vehicles, and freight trains. Noise measurements along U.S. Route 20, about 15 meters (50 feet) from the roadway, indicate that the sound levels from traffic range from 64 to 86 dBA, and that the primary source is buses (71 to 80 dBA). While few people reside within 15 meters (50 feet) of the roadway, the results indicate that INEEL traffic noise might be objectionable to members of the public residing near principal highways or busy bus routes. Noise levels along these routes may have decreased somewhat due to reductions in employment and bus service at INEEL in the last few years. The acoustic environment along the INEEL site boundary in rural areas and at nearby areas away from traffic noise is typical of a rural location; the average day-night sound level is in the range of 35 to 50 dBA. Except for the prohibition of nuisance noise, neither the State of Idaho nor local governments have established any regulations that specify acceptable community noise levels applicable to INEEL (DOE 1996b:3-114). The EPA guidelines for environmental noise protection recommend an average day-night sound level of 55 dBA as sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974:29). Land use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that yearly day-night average sound levels less than 65 dBA are compatible with residential land uses (14 CFR Part 150). These guidelines further indicate that levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures. It is expected that for most residences near INEEL, the day-night average sound levels are compatible with the residential land use, although for some residences along major roadways, noise levels may be higher than 65 dBA.

3.3.2.2 Locations of Proposed Activities

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No distinguishing noise characteristics at INTEC have been identified. INTEC is far enough from the site boundary (12 kilometers [7.5 miles]) that noise levels at the boundary from these sources are not measurable or are barely distinguishable from background levels.

TEST REACTOR AREA

No distinguishing noise characteristics at the Test Reactor Area have been identified. The Test Reactor Area is far enough from the site boundary (11 kilometers [6.8 miles]) that noise levels at the site boundary from these sources are not measurable or are barely distinguishable from background levels.

3.3.3 Air Quality

Air pollution refers to the introduction, directly or indirectly, of any substance into the air that could endanger human health, harm living resources and ecosystems as well as material property, and impair or interfere with the comfortable enjoyment of life or other legitimate uses of the environment. Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

3.3.3.1 General Site Description

The climate at INEEL and the surrounding region is characterized as that of a semiarid steppe. The average annual temperature at INEEL is 5.6 °C (42 °F); average monthly temperatures range from a minimum of -8.8 °C (16.1 °F) in January to a maximum of 20 °C (68 °F) in July. The average annual precipitation is 22 centimeters (8.7 inches) (Clawson, Start, and Ricks 1989:55, 77). Prevailing winds at INEEL are southwest or northeast (DOE 1999h:4.7-1). The annual average wind speed is 3.4 meters per second (7.5 miles per hour) (DOE 1996b:3-112).

INEEL is within the Eastern Idaho Intrastate Air Quality Control Region #61. None of the areas within INEEL and its surrounding counties are designated as nonattainment areas with respect to the NAAQS for criteria air pollutants (40 CFR Section 81.313). The nearest nonattainment area for particulate matter is in Pocatello, about 80 kilometers (50 miles) to the south. Applicable NAAQS and Idaho State ambient air quality standards are presented in **Table 3–11**.

The primary sources of air pollutants at INEEL include calcination of sodium-bearing waste, combustion of coal for steam, and combustion of fuel oil for heating. Other emission sources include waste burning, coal piles, industrial processes, stationary diesel engines, vehicles, and fugitive dust from waste burial and construction activities. The existing ambient air concentrations attributable to sources at INEEL are presented in Table 3–11. These concentrations are based on dispersion modeling using maximum emissions from 1990 and meteorological data from 1992 (DOE 1996b:3-112–3-114) (DOE 1999e:3-50). The estimated concentrations are conservative and bound the actual INEEL contribution to ambient levels, as some of the modeled sources are currently in standby. Concentrations shown in Table 3–11 represent a small percentage of the ambient air quality standards. Concentrations of any hazardous and toxic compounds would be well below regulatory levels.

Because INEEL sources are limited and background concentrations of criteria pollutants are well below ambient standards, INEEL emissions should not result in air pollutant concentrations that violate the ambient air quality standards.

The nearest Prevention of Significant Deterioration Class I area to INEEL is Craters of the Moon Wilderness Area, Idaho, 53 kilometers (33 miles) west-southwest from the center of the site. A Class I area is one in which very little increase in pollution is allowed due to the pristine nature of the area. There are no other Class I areas within 100 kilometers (62 miles) of INEEL. INEEL and its vicinity are classified as a Class II area in which more moderate increases in pollution are allowed (DOE 1996b:3-112).

Table 3–11 Comparison of Modeled Ambient Air Concentrations from INEEL Sources with Most Stringent Applicable Standards or Guidelines

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meters)[a]	INEEL Concentration (micrograms per cubic meters)
Criteria pollutants			
Carbon monoxide	8 hours	10,000[b]	284
	1 hour	40,000[b]	614
Nitrogen dioxide	Annual	100[b]	4
Ozone	1 hour	235[c]	(d)
PM_{10}	Annual	50[b]	3
	24 hours	150[b]	33
Sulfur dioxide	Annual	80[b]	6
	24 hours	365[b]	135
	3 hours	1,300[b]	579

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The NAAQS (40 CFR Part 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic PM_{10} mean standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.
b. Federal and state standard.
c. Federal 8-hour standard is currently under litigation.
d. Not directly emitted or monitored by the site.

Note: NAAQS also include standards for lead. No sources of lead emissions have been identified for any alternative evaluated. Emissions of hazardous air pollutants not listed here have been identified at INEEL, but are not associated with any of the alternatives evaluated. EPA revised the ambient air quality standards for particulate matter and ozone in 1997; however, these standards are currently under litigation. In 1999, new standards effective on September 16, 1997 could not be enforced. The ozone standard is a one-hour concentration of 235 micrograms per cubic meter (0.12 parts per million) (62 FR 38856). The 8-hour PM_{10} standard could not be enforced. The current annual PM_{10} standard is retained (62 FR 38652).
Source: 40 CFR Part 50; ID DHW 1998; Moor and Peterson 1999.

EPA has established Prevention of Significant Deterioration increments for certain pollutants: sulfur dioxide, nitrogen dioxide and particulate matter less than or equal to 10 microns in diameter (PM_{10}). The increments specify a maximum allowable increase above a certain baseline concentration for a given averaging period, and apply only to sources constructed or modified after a specified baseline date. These sources are known as increment-consuming sources. The baseline date is the date of submittal of the first application for a Prevention of Significant Deterioration permit in a given area.

Prevention of Significant Deterioration permits have been obtained for the coal-fired steam-generating facility next to the Idaho Nuclear Technology and Engineering Center and Fuel Processing Facility, which is not expected to be operated (DOE 1996b). In addition to this facility, INEEL has other increment consuming sources on site. The current amounts of Prevention of Significant Deterioration increment consumption in Class I and Class II areas by INEEL's increment-consuming sources based on dispersion modeling analyses are specified in **Tables 3–12** and **3–13**, respectively.

Routine offsite monitoring for nonradiological air pollutants is generally only performed for particulates. Monitoring for PM_{10} is performed by the Environmental Science and Research Foundation at the site boundary and at communities beyond the boundary. In 1997, 49 samples were collected at Rexburg (about 60 kilometers [19.3 miles] east of the site) by the Foundation. The mean PM_{10} concentration at Rexburg for 1997 was 14 micrograms per cubic meter. Forty-one samples were collected at the Mountain View Middle School in Blackfoot, with a mean concentration of 15 micrograms per cubic meter. Twenty-nine samples were collected at Atomic City in 1997, with a mean concentration of 15 micrograms per cubic meter (Evans et al. 1998).

Table 3–12 Prevention of Significant Deterioration Increment Consumption at Craters of the Moon Wilderness (Class I) Area by Existing (1996) and Projected Sources Subject to Prevention of Significant Deterioration Regulation

Pollutant	Averaging Time	Allowable Prevention of Significant Deterioration Increment[a] (micrograms per cubic meter)	Amount of Prevention of Significant Deterioration Increment Consumed (micrograms per cubic meter)
Nitrogen dioxide	Annual	2.5	0.004
Respirable particulates[b]	Annual	4	0.008
	24 hours	8	0.6
Sulfur dioxide	Annual	2	0.09
	24 hours	5	1.8
	3 hours	25	5.9

a. All increments specified are State of Idaho standards (ID DHW 1998).
b. Data on particulate size are not available for most sources. For purposes of comparison to the respirable particulate increments, it is conservatively assumed that all particulates emitted are of respirable size (i.e., 10 microns or less in diameter).
Source: DOE 1999h.

Table 3–13 Prevention of Significant Deterioration Increment Consumption at Class II Areas by Existing (1996) and Projected Sources Subject to Prevention of Significant Deterioration Regulation at INEEL

Pollutant	Averaging Time	Allowable Prevention of Significant Deterioration Increment[a] (micrograms per cubic meter)	Amount of Prevention of Significant Deterioration Increment Consumed (micrograms per cubic meter)
Nitrogen dioxide	Annual	25	1.4
Respirable particulates[b]	Annual	17	0.92
	24 hours	30	15
Sulfur dioxide	Annual	20	2.4
	24 hours	91	29
	3 hours	512	132

a. All increments specified are State of Idaho standards (ID DHW 1998).
b. Data on particulate size are not available for most sources. For purposes of comparison to the respirable particulate increments, it is conservatively assumed that all particulates emitted are of respirable size (i.e., 10 microns or less in diameter).
Source: DOE 1999h.

Some monitoring data has also been collected by the National Park Service at the Craters of the Moon Wilderness Area. The monitoring program has shown no exceedances of the 1-hour ozone standard, low levels of sulfur dioxide (except for one exceedance of the 24-hour standard in 1985), and total suspended particulates within applicable standards (DOE 1999h). Note that the total suspended particulate standards have been replaced with PM_{10} standards.

3.3.3.2 Locations of Proposed Activities

The meteorological conditions for INEEL are considered to be representative of the INTEC and Test Reactor Area sites.

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Primary sources of nonradiological air pollutants include the New Waste Calcining Facility and coal-fired steam generating facilities. Both of these facilities are in standby. These facilities are sources of carbon monoxide, nitrogen dioxide, sulfur dioxide and PM_{10}. The New Waste Calcining Facility is a large source of nitrogen dioxide at INEEL.

TEST REACTOR AREA

The ATR facility operates a diesel generator as a source of backup electrical power. This generator is a significant source of nonradioactive air emissions at ATR. Other diesel engines are also operated periodically and contribute to air emissions (LMIT 1997:11–23).

3.3.4 Water Resources

Water resources include all forms of surface water and subsurface groundwater.

3.3.4.1 Surface Water

Surface water includes marine or freshwater bodies that occur above the ground surface, including rivers, streams, lakes, ponds, rainwater catchments, embayments, and oceans.

3.3.4.1.1 General Site Description

INEEL is in the Pioneer Basin, a closed basin drained by three intermittent streams: Big Lost River, Little Lost River, and Birch Creek. These intermittent streams drain the mountains to the north and west of the site and carry snowmelt in the spring, but are usually dry by midsummer. Once every several years offsite waters enter DOE property. Big Lost River and Birch Creek are the only streams that regularly flow onto INEEL. Little Lost River is usually dry by the time it reaches the site because of upstream use of the flow for irrigation. None of the rivers flow from the site to offsite areas. Big Lost River discharges into the Big Lost River sinks, and there is no surface discharge from these sinks (Barghusen and Feit 1995:2.3-2, 2.3-21; DOE 1995a:4.8-1, 4.8-2; DOE 1996b:3-115). Other than the three intermittent streams, the only other surface water bodies on the site include natural wetland-like ponds and manmade percolation and evaporation ponds (DOE 1999h:4.8-1).

Big Lost River, Little Lost River, and Birch Creek have been classified by the State of Idaho for irrigation for agriculture, cold water biota development, salmon spawning, and primary and secondary recreation (DOE 1999h:4.8-9). Surface waters, however, are not used for drinking water on the site, nor is effluent discharged directly to them; thus, there are no surface water rights issues at INEEL. None of the rivers have been classified as a Wild and Scenic River. A diversion dam constructed in 1958 and enlarged in 1984 secured INEEL from the 300-year flood by directing flow through a diversion channel into four spreading areas (DOE 1995a:4.8-3, 4.8-4, 4.8-13; DOE 1996b:3-115).

3.3.4.1.2 Locations of Proposed Activities

There are no named streams within INTEC and the Test Reactor Area; only unnamed drainage ditches which carry storm flows away from buildings and facilities at the site. Outside INTEC and the Test Reactor Area, the only surface water is a stretch of Big Lost River. This is an intermittent stream that flows only after rainfall events or in the spring, when it carries snowmelt from the nearby mountains (Abbott, Crockett, and Moor 1997:5). The stream channel is 1,365 meters (4,480 feet) from the southeast corner of the Test Reactor Area fenced boundary (LMIT 1997:2-47). During the period September 1995 to July 1996, flow of the Big Lost River on INEEL averaged 1.51 cubic meters per second (53.5 cubic feet per second) with the highest one-day flow of 10.36 cubic meters per second (366 cubic feet per second) (DOE 1999h:4.8-1). A summary of water quality data for Big Lost River in the vicinity of INEEL is provided in the *Storage and Disposition PEIS* and shows no unusual concentrations of the parameters analyzed (DOE 1996b:3-115–3-117). In general, the water quality of Big Lost River, Little Lost River, and Birch Creek is similar with the chemical quality reflecting the mineral composition of the mountain ranges drained by them, along with the quality of irrigation water return flows (DOE 1995a:4.8-4).

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Sanitary waste with no potential for radioactive contamination is treated in the INTEC Sewage Treatment Facility (CPP-615). This facility has a Wastewater Land Application Permit from the State of Idaho and does not discharge to surface waters. However, the permit allows land application of treated sanitary sewage. The only effluent criteria associated with flows to the sewage ponds are the amounts of total suspended solids and nitrogen released to the ponds. All compliance points for the ponds are in wells downgradient from the ponds, and the maximum allowable concentrations are similar to those in the National Primary and Secondary Drinking Water Standards (Abbott, Crockett, and Moor 1997:9, 10). Drainage from corridors, roof and floor drains, and condensate from process heating, and heating, ventilation, and air conditioning systems, with very low potential for radiological contamination are routed to the INTEC service waste system. Service Waste Percolation Pond 1, southeast of Building CPP–603, has a surface area of about 18,400 square meters (198,000 square feet) and is 4.9 meters (16 feet) deep. It has a disposal capacity of 5.7 million liters per day (1.5 million gallons per day). Service Waste Pond 2, immediately west of Service Waste Percolation Pond 1, has a surface area of 46 square meters (495 square feet). It has a disposal capacity of 11 million liters per day (3 million gallons per day). Both ponds are fenced to keep out wildlife (Abbott, Crockett, and Moor 1997:9). Based on 1997 monitoring results from the INTEC service waste system, none of the parameter concentrations exceeded applicable standards that would define the effluent as hazardous (Evans et al. 1998:7-7, 7-8).

Consideration is being given to relocating the percolation pond to reduce the potential impacts on a contaminated perched water zone. Consideration is also being given to obtaining an NPDES permit to allow direct discharge into Big Lost River. These actions are independent of the proposed action analyzed in this NI PEIS and would be preceded by appropriate NEPA documentation (Abbott, Crockett, and Moor 1997:10).

Flooding scenarios that involve the failure of MacKay Dam and high flows in the Big Lost River have been evaluated. The results indicate that in the event of a failure of this dam, flooding would occur at INTEC. The low velocity and shallow depth of the water, however, would not pose a threat of structural damage to the facilities. Localized flooding can occur due to rapid snowmelt and frozen ground conditions, but none has been reported at INTEC (Barghusen and Feit 1995:2.3-21, 2.3-23).

A 1999 Bureau of Reclamation paleoflood study confirms that while INTEC is potentially subject to flooding by the Big Lost River, it is predominantly sited on geomorphic surfaces that are well in excess of 10,000 years of age, indicating that the hazard of significant flooding is low under natural channel conditions. However, extensive modification of the Big Lost River channel throughout much of INEEL indicates that the characterization of flood stage due to Big Lost River flows will require a detailed assessment of channel stability and behavior for different flows (DOI 1999). The 500-year flood has not been studied, and no flood maps are available from Federal Emergency Management Agency or other agencies (Abbott, Crockett, and Moor 1997:7). However, the probable maximum flood has been calculated, as shown on **Figure 3–4.**

TEST REACTOR AREA

Radiological liquid effluents at the Test Reactor Area result from canal wastewater, primary coolant leakage, and activities associated with ATR power monitoring. This process water is treated by the ATR Warm Waste Treatment Facility system. The resultant wastewater, containing tritium, limited concentrations of activation, and fission products below the volatile and nonvolatile release limits established by the State of Idaho, is released to the Test Reactor Area Warm Waste Evaporation Pond, Test Reactor Area-715. As a result, there is no direct discharge to groundwater. Nevertheless, this released wastewater is also below applicable

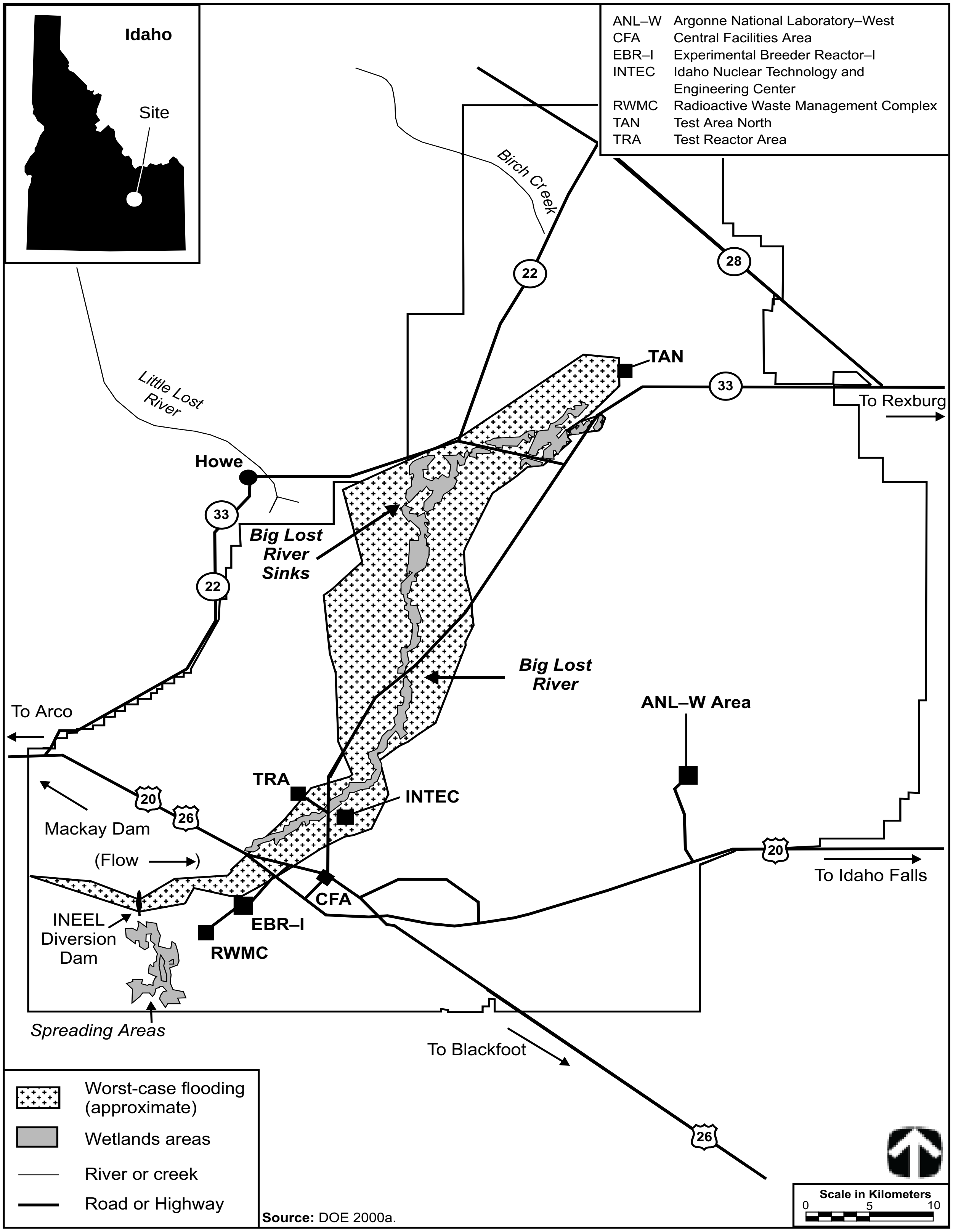

Figure 3–4 Flood Area for the Probable Maximum Flood-Induced Overtopping Failure of the Mackay Dam

requirements for nonradiological hazardous constituents specified in the pond operating permit (LMIT 1997:11-10, 11-11, 11-42; Moor and Peterson 1999:7). The ATR Warm Waste Treatment Facility has a design flow rate of 567.8 liters (150 gallons) per minute or about 817,646 liters per day (216,000 gallons per day) (LMIT 1997:11-41, 11-43).

Nonradiological waste effluents collect at the cold well sump (Test Reactor Area-703) and sampling station (Test Reactor Area-764) where they are collected continuously, sampled daily, and pumped out to the cold-waste percolation pond (Test Reactor Area-702) located outside Test Reactor Area fence. Sampling data indicate that during routine operation, the Test Reactor Area cold waste effluent is characterized as nonhazardous industrial wastewater (LMIT 1997:11-10, 11-11; Moor and Peterson 1999:7).

Flooding scenarios that involve the failure of MacKay Dam have been evaluated and the results indicate that flood waters would not reach ATR, even if the failure was concurrent with the probable maximum flood (Figure 3–4). The effects of intense local precipitation and snowmelt runoff have also been evaluated and are not expected to result in flood damage to ATR because the reactor building main floor is at a higher elevation than its surroundings (LMIT 1997:2-47-2-51).

The 1999 Bureau of Reclamation flood study described earlier also evaluated the potential for flooding at Test Reactor Area and reached the same conclusions as for INTEC.

3.3.4.2 Groundwater

Aquifers are classified by Federal and state authorities according to use and quality. The Federal classifications include Classes I, IIA, IIB, and III groundwater. Class I groundwater is either the sole source of drinking water or is ecologically vital. Classes IIA and IIB are current or potential sources of drinking water or other beneficial use, respectively. Class III is not considered a potential source of drinking water and is of limited beneficial use.

3.3.4.2.1 General Site Description

The Snake River Plain aquifer is classified by EPA as a Class I sole source aquifer. It lies below the INEEL site and covers about 2,486,000 hectares (6,143,000 acres) in southeastern Idaho. This aquifer serves as the primary drinking water source in the Snake River Basin and is believed to contain 1.2 quadrillion to 2.5 quadrillion liters (317 trillion to 660 trillion gallons) of water. The aquifer consists of 610 to 3,048 meters (2,000 to 10,000 feet) of interbedded sediments, lava flows, and rhyolite. Recharge of the groundwater comes from Henry's Fork of the Snake River, Big Lost River, Little Lost River, and Birch Creek. Rainfall and snowmelt also contribute to the aquifer's recharge (DOE 1996b:3-115–3-117). Groundwater generally flows laterally at a rate of 1.5 to 6.1 meters per day (5 to 20 feet per day). Groundwater flow is toward the south-southwest. It emerges in springs along the Snake River from Milner to Bliss, Idaho. Depth to the groundwater table ranges from about 60 meters (200 feet) below ground in the northeast corner of the site, to about 300 meters (1,000 feet) in the southeast corner (DOE 1995a:4.8-5, DOE 1996b:3-117). Perched water tables occur below the site. These perched water tables tend to slow the migration of pollutants that might otherwise reach the Snake River Plain aquifer (DOE 1996b:3-117). Perched water tables have been detected beneath INTEC and the Test Reactor Area attributable to disposal ponds (DOE 1995a:4.8-8).

INEEL has a large network of monitoring wells; about 120 in the Snake River Plain aquifer and 100 drilled in the perched zone. The wells are used for monitoring to determine the compliance of specific actions with requirements of RCRA and CERCLA, as well as routine monitoring to evaluate the quality of the water in the aquifer. The aquifer is known to have been contaminated with tritium; however, the concentration dropped 93 percent between 1961 and 1994, possibly due to the elimination of tritium disposal, radioactive decay, and dispersion throughout the aquifer. Other known contaminants include cesium-137, iodine-129, strontium-90, and nonradioactive compounds such as trichloroethylene. Components of nonradioactive waste entered the aquifer as a result of past waste disposal practices. Elimination of groundwater injection exemplifies a change in disposal practices that has reduced the amount of these constituents in the groundwater (DOE 1996b:3-117, 3-119). Information on more recent groundwater monitoring and chemical analysis is presented in the annual site environmental report (Evans et al. 1998).

From 1982 to 1985, INEEL used about 7.9 billion liters per year (2.1 billion gallons per year) from the Snake River Plain aquifer, the only source of water at INEEL. This represents less than 0.3 percent of the groundwater withdrawn from that aquifer. Since 1950, DOE has held a Federal Reserved Water Right for the INEEL site that permits a pumping capacity of approximately 2.3 cubic meters per second (80 cubic feet per second), with a maximum water consumption of 43 billion liters per year (11 billion gallons per year). Total groundwater withdrawal at INEEL averages between 15–20 percent of that permitted amount (DOE 1996b:3-119; Moor and Peterson 1999:6).

3.3.4.2.2 Locations of Proposed Activities

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Water for INTEC is supplied by two deep wells in the northwest corner of the area. The wells are about 180 meters (590 feet) deep and about 36 centimeters (14 inches) in diameter (Abbott, Crockett, and Moor 1997:9). These wells can each supply up to approximately 11,000 liters per minute (3,000 gallons per minute) of water for use in the INTEC fire water, potable water, treated water, and demineralized water systems (Werner 1997). Pumping has little effect on the level of the groundwater, because the withdrawals are small relative to the volume of water in the aquifer and the amount of recharge available. The production wells at INTEC have historically contained measurable quantities of strontium-90 (Barghusen and Feit 1995:2.3-23–2.3-29).

Water from the production and potable wells at INTEC and other facilities were sampled and analyzed once in 1997 for lead, silver, and nitrogen as nitrate. None of these constituents were above the EPA maximum contaminant levels or the State of Idaho drinking water limits. Additional sampling was conducted in 1997 for a variety of inorganic constituents, including metals, nitrates, and dissolved solids. There were no instances where the maximum contaminant levels were exceeded (Evans et al. 1998:6-8, 6-10).

Purgeable organics such as 1,1-dichloroethylene, toluene, and 1,1,1-trichloroethane have been detected in monitoring wells near INTEC. Metals, including arsenic, barium, lead, mercury, selenium, and silver, were also found in samples from wells. Inorganic chemicals such as sodium and chloride have been found in these samples. Maximum values for tritium in samples from three wells averaged 23,700 picocuries per liter; and maximum strontium-90 values averaged 53 picocuries per liter (Abbott, Crockett, and Moor 1997:11, 12). These values exceed the drinking water standards for tritium and strontium-90 of 20,000 picocuries per liter and 8 picocuries per liter, respectively. The results of groundwater modeling and baseline risk assessment will be used to identify the release sites requiring further evaluation. If necessary, removal actions may be taken to prevent further migration of contaminants to the Snake River Plain Aquifer (Mitchell et al. 1997:3-5).

Historical waste disposal practices have produced localized plumes of radiochemical and chemical constituents in the Snake River Plain Aquifer at INEEL. Of principal concern over the years has been the movements of the tritium and strontium-90 plumes. The main sources of tritium contamination of groundwater have been the injection of wastewater through the INTEC disposal well and the discharge of wastewater to the infiltration ponds at INTEC and Test Reactor Area. Since 1984, wastewater has been discharged only to the infiltration ponds, and since 1993 principally to lined evaporation ponds. The extent of the tritium contamination plume has remained about the same since 1991; however, concentrations in well water within the plume have decreased significantly. This is attributed to radioactive decay and a decrease in tritium disposal rates (Evans et al. 1998:6-12, 6-13).

The extent of the strontium-90 contaminant plume, originating from INTEC, as well as the concentrations of strontium-90 have remained essentially constant since 1991. This is attributed to a lack of groundwater recharge from the Big Lost River, and to the disposal of other chemicals in the INTEC infiltration ponds which may have decreased strontium-90 adsorption to soil and rock causing more to remain in the liquid phase (Evans et al. 1998:6-13).

TEST REACTOR AREA

All water used at Test Reactor Area is groundwater from the Snake River Plain aquifer tapped by three deep wells. The depth to the groundwater at the Test Reactor Area is approximately 140 meters (460 feet). In general, Test Reactor Area, including ATR, uses approximately 190 million liters (50 million gallons) per month of water (Moor and Peterson 1999:6; LMIT 1997:2-59).

In 1997, groundwater in the vicinity of the Test Reactor Area was monitored for purgeable organics such as total trihalomethanes (bromodichloromethane, bromoform, chloroform and dibromochloromethane), and inorganics such as nitrogen as nitrate. All monitored concentrations of total trihalomethanes in 1997 were below the maximum contaminant level of 100 micrograms per liter. The highest reported concentration was 4.2 micrograms per liter. In 1997, the monitored nitrogen as nitrate concentration of 1.0 milligrams per liter was also below its maximum contaminant level of 10 milligrams per liter (Evans et al. 1998:6-8, 6-10, 6-12).

3.3.5 Geology and Soils

Geologic resources are consolidated or unconsolidated earth materials, including ore and aggregate materials, fossil fuels, and significant landforms. Soil resources are the loose surface materials of the earth in which plants grow, usually consisting of disintegrated rock, organic matter, and soluble salts.

3.3.5.1 General Site Description

INEEL is on the northwestern edge of the eastern Snake River Plain that is bounded on the north and south by north to northwest trending mountains and valleys of the Basin and Range physiographic province (DOE 1999h:4.6-1; LMIT 1997:2A-3). The upper 1 to 2 kilometers (0.6 to 1.2 miles) of the crust beneath INEEL is composed of interlayered basalt and sediment. The sediments are composed of fine-grained silts that were deposited by wind; silts, sands, and gravels deposited by streams; and clays, silts, and sands deposited in lakes. Rhyolitic (granite-like) volcanic rocks of unknown thickness lie beneath the basalt sediment sequence. The rhyolitic volcanic rocks were erupted between 4.3 and 6.5 million years ago (Barghusen and Feit 1995:2.3-17). Lava tubes, which could have similar adverse effects as karst, occur in the INEEL area (Abbott, Crockett, and Moor 1997:10).

Within INEEL, economically viable sand, gravel, pumice, silt, clay, and aggregrate resources exist. Several quarries supply these materials to various onsite construction and maintenance projects (DOE 1999h:4.6-4). Geothermal resources are potentially available in parts of the Eastern Snake River Plain, but neither of two boreholes drilled near INTEC encountered rocks with significant geothermal potential (Abbott, Crockett, and Moor 1997:12).

The Arco Segment of the Lost River Fault is thought to terminate about 7 kilometers (4.3 miles) from the INEEL boundary. The Howe Segment of the Lemhi Fault terminates near the northwest boundary of the site

(LMIT 1997:2A-44, 2A-45, 2A-77). Both segments are considered capable. A capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years, or recurrent movement within the past 500,000 years (10 CFR Part 100, Appendix A).

The seismic characteristics of the Eastern Snake River Plain and the adjacent Basin and Range Province are different; the Snake River Plain has historically experienced few and small earthquakes (DOE 1999h:4.6-1). Monitoring by the INEEL seismic network has detected only a few microearthquakes (magnitude less than 1.5 on the Richter Scale) as having occurred on or near the site (Barghusen and Feit 1995:2.3-17; Jackson et al. 1993:680–695).

The largest historic earthquake near INEEL took place in 1983, 107 kilometers (66 miles) to the northwest, near Borah Peak in the Lost River Range. It occurred on the middle portion of the Lost River Fault. The earthquake had a moment magnitude of 6.9 with a ground acceleration of 0.022 g to 0.078 g at INEEL (DOE 1999h:E-2-1; Jackson 1985). The Test Reactor Area (i.e., ATR) experienced a Modified Mercalli Intensity of VI during this event with no damage to ATR found upon inspection (LMIT 1997:2A-29). An earthquake with a maximum horizontal acceleration of 0.15 g is calculated to have annual probability of occurrence of 1 in 5,000 at a central INEEL location (Barghusen and Feit 1995:2.3-17).

As discussed in more detail in Section 3.2.5.1, USGS has developed new seismic hazard maps as part of the National Seismic Hazard Mapping Project that are based on response spectral acceleration. These maps have been adapted for use in the new *International Building Code* (ICC 2000) (Figures 1615 (1) and 1615(2) in the code) and depict maximum considered earthquake ground motion of 0.2 and 1.0 second spectral response acceleration, respectively, based on a 2 percent probability of exceedance in 50 years. INEEL lies within the 0.35 to 0.40 g mapping contours for a 0.2-second spectral response acceleration and the 0.10 to 0.15 g contours for a 1.0-second spectral response acceleration.

Basaltic volcanic activity occurred from about 2,100 to 4 million years ago in the INEEL site area. Although no eruptions have occurred on the Eastern Snake River Plain during recorded history, lava flows of the Hell's Half Acre lava field erupted near the southern INEEL boundary as recently as 5,400 years ago. The most recent eruptions within the site area occurred about 2,100 years ago 30 kilometers (19 miles) southwest of the site at the Craters of the Moon Wilderness Area. Five volcanic zones have been identified on INEEL. The estimated recurrence interval for volcanism in theses zones ranges from 16,000 to 100,000 years (DOE 1999h:4.6-3, 4.6-4; Hackett and Smith 1994).

Four basic soilscapes exist at INEEL: river-transported sediments deposited on alluvial plains, fine-grained sediments deposited into lake or playa basins, colluvial sediments originating from bordering mountains, and wind-blown sediments over lava flows. The alluvial deposits follow the courses of the modern Big Lost River and Birch Creek. The playa soils are in the north-central part of the site. The colluvial sediments are along the western edge of INEEL. Wind-blown sediments (silt and sand) covering lava plains occupy the rest of the landscape of the site (DOE 1997b:52–54). The thickness of surfical sediments ranges from less than 0.3 meters (1 foot) at basalt outcrops east of INTEC to 95 meters (312 feet) near the Big Lost River sinks (DOE 1999h:4.6-1). No prime farmland lies within INEEL boundaries (DOE 1999e:3-71).

3.3.5.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

The nearest capable fault to INTEC is the Howe Segment of the Lemhi Fault, located about 19 kilometers (12 miles) north of the site. While lava tubes do occur in the INEEL area, extensive drilling in the INTEC area has not revealed any lava tubes below the site. All soil near INTEC was originally fine loam over a sand or sand-cobble mix deposited in the floodplain of the Big Lost River. However, all soils within INTEC fences have been disturbed. The soils beneath INTEC area are not subject to liquefaction because of the high content of gravel mixed with the alluvial sands and silts. In addition, the sediments are not saturated (Abbott, Crockett, and Moor 1997:10, 13; LMIT 1997:2A-82).

TEST REACTOR AREA

The nearest capable fault to the Test Reactor Area is the Howe Segment of the Lemhi Fault, which is about 19 kilometers (12 miles) north-northeast of ATR (LMIT 1997:2A-82). There is no potential for unstable conditions due to lava tubes at the site. Soils on the site, although highly disturbed by existing facilities, are derived from Big Lost River alluvial sand, silt, and gravel deposits and are of variable depth. The soils are not subject to liquefaction (LMIT 1997:2A-17, 2A-83; Moor and Peterson 1999:7).

3.3.6 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Material presented in this section, unless otherwise noted, is from the *Storage and Disposition PEIS* (DOE 1996b).

3.3.6.1 Terrestrial Resources

This section addresses the plant and animal communities of INEEL and includes a plant community map of the site. Terrestrial resources are described for the site as a whole, as well as for the proposed facility locations.

3.3.6.1.1 General Site Description

INEEL lies in a cool desert ecosystem dominated by shrub-steppe communities. Most land within the site is relatively undisturbed and provides important habitat for species native to the region. Facilities and operating areas occupy 2 percent of INEEL; approximately 60 percent of the area around the periphery of the site is grazed by sheep and cattle. Although sagebrush communities occupy about 80 percent of INEEL, a total of 20 plant communities have been identified (**Figure 3–5**). In total, 398 plant taxa have been documented at INEEL.

The interspersion of low and big sagebrush communities in the northern portion of INEEL, and juniper communities in the northwestern and southeastern portions of the site are considered sensitive habitats. The former provides critical winter and spring range for sage grouse and pronghorn, while the latter is important to nesting raptors and songbirds. Riparian vegetation, primarily cottonwood and willow along the Big Lost River and Birch Creek provides nesting habitat for hawks, owls, and songbirds. Recently, approximately 29,950 hectares (74,000 acres) of open space in the north central portion of the site have been designated as the INEEL Sagebrush Steppe Ecosystem Reserve (DOE 1999g). The area represents some of the last sagebrush steppe habitat in the United States and provides habitat for numerous rare and sensitive plants and animals.

INEEL supports numerous animal species, including two amphibian, 11 reptile, 225 bird, and 44 mammal species (Reynolds 1999). Common animals on INEEL include the short-horned lizard, gopher snake, sage sparrow, Townsend's ground squirrel, and black-tailed jackrabbit. Important game animals include the sage grouse, mule deer, elk, and pronghorn. During some winters, 4,500 to 6,000 pronghorn, or about 30 percent of Idaho's total pronghorn population, may be found on INEEL. Pronghorn wintering areas are located in the northeastern portion of the site, in the area of the Big Lost River sinks, in the west-central portion of the site along the Big Lost River, and in the south-central portion of the site (DOE 1996b:3-125). Hunting elk and

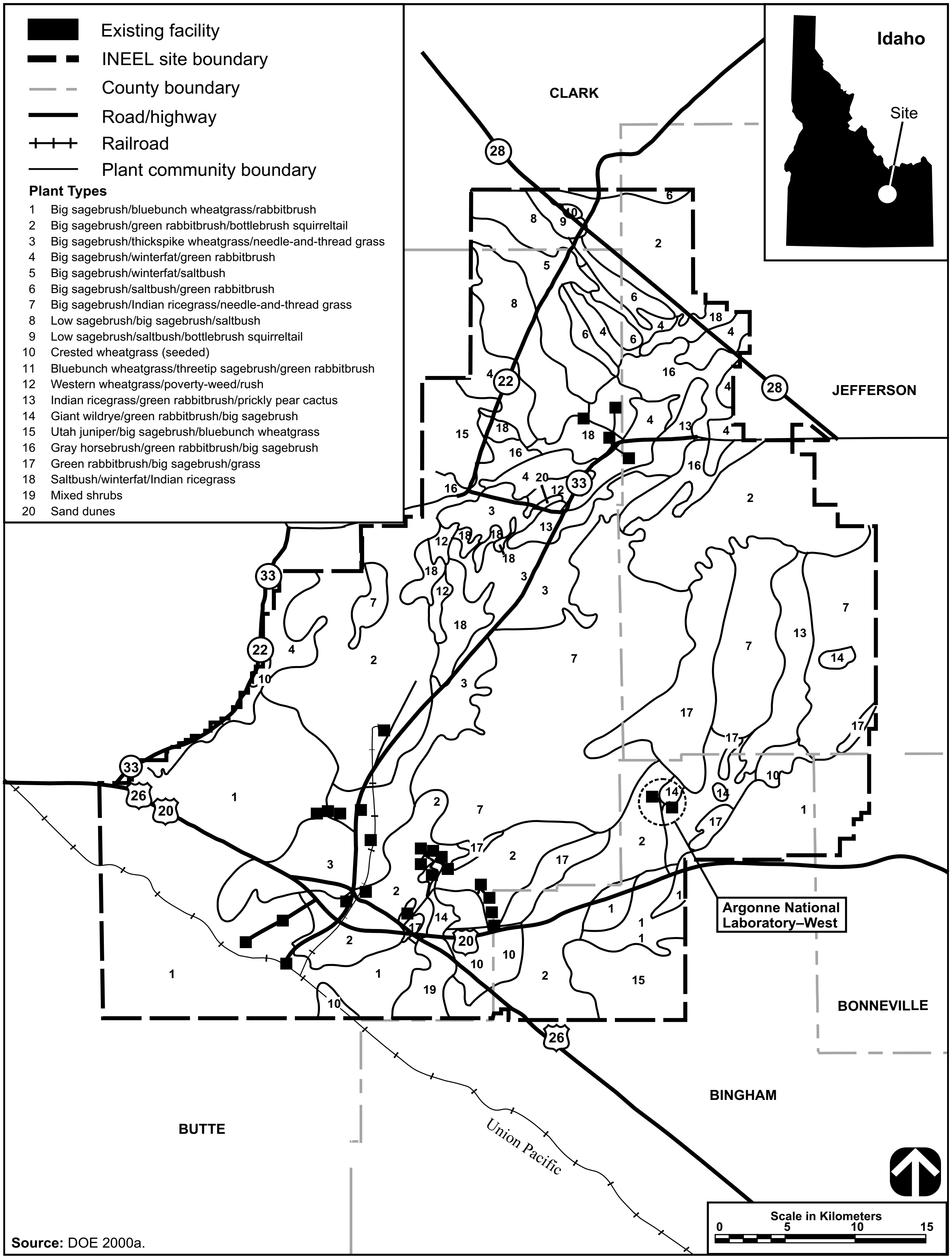

Figure 3–5 Distribution of Plant Communities at Idaho National Engineering and Environmental Laboratory

pronghorn is permitted only within 0.8 kilometers (0.5 miles) of the site boundary on INEEL lands adjacent to agricultural lands (DOE 1997b). Numerous raptors, such as the golden eagle and prairie falcon, and carnivores, such as the coyote and mountain lion, are also found on INEEL. A variety of migratory birds have been found at INEEL.

3.3.6.1.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

INTEC is within an area dominated by big sagebrush communities. The site itself is developed with little vegetation, other than that associated with landscaped areas. In fact, bare ground comprises 85 percent of the site, while facilities and pavement make up 13 percent of the area. Animal species present at INTEC are primarily limited to those adapted to disturbed industrial areas, such as mice, rabbits, sparrows, finches, and lizards (DOE 1999e:3.3.8.1.2). Wastewater ponds associated with INTEC attract a variety of wildlife (Cieminski and Flake 1995:105).

TEST REACTOR AREA

Vegetative communities in which big sagebrush is the dominant plant occur in the vicinity of the Test Reactor Area (Figure 3–5). Grasslands comprised primarily of wheat grasses also occur in the area. The Test Reactor Area itself is a developed area with little or no vegetation. Lawns and ornamental vegetation are used by a number of species such as songbirds, raptors, rabbits, and mule deer. Ponds in and around the Test Reactor Area are known to be frequented by waterfowl, shorebirds, swallow, passerines, and to a limited extent, by raptors such as the American kestrel, ferruginous hawk, and northern harrier. Mammals have been observed at the disposal ponds despite perimeter fences, and amphibians have been reported at Test Reactor Area industrial waste and sewage disposal ponds (Moor and Peterson 1999:9).

3.3.6.2 Wetlands

Wetlands include "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR Section 328.3). Wetlands are described for INEEL as a whole, as well as for the proposed facility locations.

3.3.6.2.1 General Site Description

National Wetland Inventory maps prepared by the U.S. Fish and Wildlife Service have been completed for most of INEEL. These maps indicate that the primary wetland areas are associated with the Big Lost River, the Big Lost River spreading areas, and the Big Lost River sinks, although smaller (less than about 0.4 hectares [1 acre]) isolated wetlands also occur. Wetlands associated with the Big Lost River are classified as riverine/intermittent, indicating a defined stream channel with flowing water during only part of the year. The only area of jurisdictional wetland is the Big Lost River sinks (Evans et al. 1998, 2-7). Wetland areas on INEEL are shown in Figure 3–5.

3.3.6.2.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

The Big Lost River spreading areas and Big Lost River sinks are seasonal wetlands and are approximately 14 kilometers (8.7 miles) southwest, and 25 kilometers (15.5 miles) north of INTEC. These areas can provide more than 809 hectares (2,000 acres) of wetland habitat during wet years. Riparian wetland vegetation exists along the Big Lost River and along Birch Creek. Plants found along the Big Lost River, which is about 0.8 kilometer (0.5 mile) northwest of the site, are in poor condition due to recent years of only intermittent flows. There are no wetlands within the immediate INTEC area (Abbott, Crockett, and Moor 1997:15).

TEST REACTOR AREA

The Big Lost River, Big Lost River spreading areas, and the Big Lost River sinks are about 2 kilometers (1.2 miles) southeast, 13 kilometers (8 miles) southwest, and 21 kilometers (13 miles) north-northeast of the Test Reactor Area. Natural wetlands do not occur in the immediate vicinity of the Test Reactor Area.

3.3.6.3 Aquatic Resources

Aquatic resources at INEEL are described for the site as a whole, as well as for the proposed facility location.

3.3.6.3.1 General Site Description

Aquatic habitat on INEEL is limited to the Big Lost River, Little Lost River, Birch Creek, and a number of liquid waste disposal ponds. All three streams are intermittent and drain into four sinks in the north-central part of the site. Six species of fish have been observed within water bodies located on site (Reynolds 1999). Species observed in the Big Lost River include: brook trout, rainbow trout, mountain whitefish, speckled dace, shorthead sculpin, and kokanee salmon. The Little Lost River and Birch Creek, northwest and northeast of the Test Reactor Area, respectively, enter INEEL only during periods of high flow. Surveys of fish in these surface water bodies have not been conducted. The liquid waste disposal ponds on INEEL, while considered aquatic habitat, do not support fish.

3.3.6.3.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

There is no natural aquatic habitat on the INTEC site. The nearest such habitat is the Big Lost River which is about 0.8 kilometer (0.5 mile) to the northwest. Disposal ponds in the vicinity of INTEC do not support populations of fish. However, these ponds do support a variety of aquatic invertebrates (Cieminski and Flake 1995).

TEST REACTOR AREA

Although a number of disposal ponds occur in the vicinity of the Test Reactor Area, they do not support populations of fish. Aquatic invertebrates, however, are supported by habitat provided by the ponds (Moor and Peterson 1999:9). The Big Lost River is 2 kilometers (1.2 miles) southeast of the Test Reactor Area.

3.3.6.4 Threatened and Endangered Species

Endangered species are those plants and animals in danger of extinction throughout all or a large portion of their range. Threatened species are those species likely to become endangered within the foreseeable future. Threatened and endangered species are described for INEEL as a whole, as well as for the proposed facility locations.

3.3.6.4.1 General Site Description

Nineteen Federal and state-listed threatened, endangered, and other special status species may be found on and in the vicinity of INEEL, 12 of which have been observed at the site (see Table 3.4.6–1 of the *Storage and Disposition PEIS* (DOE 1996b:3-128). One of these species is federally and state listed. The bald eagle is listed by the U.S. Fish and Wildlife Service as threatened (but has been proposed to be delisted) and by the State of Idaho as endangered. The bald eagle has rarely been seen in the western and northern portion of INEEL. The occurrence of the gray wolf (listed endangered, experimental population) on the INEEL is unverified. However, because of anecdotal evidence and because the wolf is federally listed, the species has been included on the U.S. Fish and Wildlife update for the site (Moor and Peterson 1999:11). No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act*, exists on INEEL. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service. Consultation has also been initiated with the state.

3.3.6.4.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

No threatened, endangered or other special status plant or wildlife species have been recorded at or within 0.5 kilometer (0.3 mile) of INTEC (Abbott, Crockett, and Moor 1997:15). The common loon, listed by Idaho as a species of special concern, was observed once at a percolation pond during a 3-year study in the early 1990s (Werner 1997:7). Other state species of special concern potentially occurring in the vicinity of the site include the black tern, loggerhead shrike, northern goshawk, trumpeter swan, pygmy rabbit, and Townsend's western big-eared bat. A complete list of threatened, endangered, or other special status species potentially occurring in areas surrounding INTEC is provided in the *Surplus Plutonium Disposition EIS* (DOE 1999e).

TEST REACTOR AREA

No threatened, endangered, or other special status plant or wildlife species have been recorded at or near the Test Reactor Area. However, one federally listed species, the bald eagle, and a number of state-listed species of special concern potentially occur in the area. State species of special concern include the northern goshawk, loggerhead shrike, black tern, trumpeter swan, pygmy rabbit, and Townsend's western big-eared bat. Of these species, only the loggerhead shrike is commonly seen in areas surrounding the Test Reactor Area (Moor and Peterson 1999:10-11).

3.3.7 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. INEEL has a well-documented record of cultural and paleontological resources. Guidance for the identification, evaluation, recordation, curation, and management of these resources is included in the *Idaho National Engineering Laboratory Management Plan for Cultural Resources (Final Draft)* (Miller 1995). Past studies, which covered 4 percent of the site, identified 1,506 cultural resource sites and isolated finds including 688 prehistoric sites, 38 historic sites, 753 prehistoric isolates, and 27 historic isolates (DOE 1996b). As of January 1998, approximately 7 percent of INEEL had been surveyed, raising the number of potential archeological sites to 1,839 (DOE 1999h). Most surveys have been conducted near major facility areas in conjunction with major modification, demolition, or abandonment of site facilities.

Cultural sites are often occupied continuously or intermittently over substantial time spans. For this reason, a single location may contain evidence of use during both historic and prehistoric periods. In the discussions that follow, the numbers of prehistoric and historic resources are presented. However, the sum of these resources may be greater than the total number of sites reported due to this dual-use history at sites. Therefore, where the total number of sites reported is less than the sum of prehistoric and historic sites, certain locations were used during both periods.

3.3.7.1 Prehistoric Resources

Prehistoric resources are physical properties that remain from human activities that predate written records.

3.3.7.1.1 General Site Description

Prehistoric resources identified at INEEL are generally reflective of Native American hunting and gathering activities. Resources appear to be concentrated along the Big Lost River and Birch Creek, atop buttes, and within craters or caves. They include residential bases, campsites, caves, hunting blinds, rock alignments, and limited-activity locations such as lithic and ceramic scatters, hearths, and concentrations of fire-affected rock. Most sites have not been formally evaluated for nomination to the National Register of Historic Places, but are considered to be potentially eligible. Given the rather high density of prehistoric sites at INEEL, additional sites are likely to be identified as surveys continue.

3.3.7.1.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

The INTEC area has been subjected to a number of archaeological survey projects over the past two decades. Most of these investigations have been concentrated around the perimeter of the site and along existing roadways or power line corridors. Survey coverage within 1 kilometer (0.6 mile) of Building 691, located roughly in the center of INTEC, is complete. Archaeological resources identified within the surveyed area include prehistoric isolates such as camp sites and isolated artifacts reflecting Native American hunting and gathering activities. These resources are not likely to yield additional information and are, therefore, not likely to be potentially eligible for National Register nomination (Abbott, Crockett, and Moor 1997:16).

TEST REACTOR AREA

A variety of archaeological survey projects have been completed in the Test Reactor Area. During a 1984 examination of a 100-meter-wide (328-foot-wide) corridor surrounding the fenced perimeter of the Test Reactor Area, no prehistoric resources were identified. It is also unlikely that undisturbed prehistoric resources are present within the fenced perimeter of the facility, although no specific archaeological surveys have been conducted inside the fence. Although no prehistoric sites are known to occur around the periphery of the Test Reactor Area, significant sites have been documented in the vicinity, including a multi-component archaeological site, and smaller Native American campsites (Moor and Peterson 1999:12).

3.3.7.2 Historic Resources

Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are generally considered to be those that date no earlier than 1492.

3.3.7.2.1 General Site Description

Thirty-eight historic sites and 27 historic isolates have been identified at INEEL. These resources are representative of European-American activities, including fur trapping and trading, immigration, transportation, mining, agriculture, and homesteading, as well as more recent military and scientific/

engineering research and development activities. Examples of historic resources include Goodale's Cutoff (a spur of the Oregon Trail), remnants of homesteads and ranches, irrigation canals, and a variety of structures from the World War II era. The experimental Breeder Reactor I, the first reactor to achieve a self-sustaining chain reaction using plutonium instead of uranium as the principal fuel component, is listed on the National Register of Historic Places and is designated as a National Historic Landmark. Many other INEEL structures built between 1949 and 1974 are considered eligible for the National Register because of their exceptional scientific and engineering significance, and their major role in the development of nuclear science and engineering since World War II. Additional historic sites are likely to exist in unsurveyed portions of INEEL. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office.

3.3.7.2.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

Two historic sites that may be eligible for nomination to the National Register of Historic Places, a homestead and nearby trash dump, have been identified near INTEC. These sites are potential sources of information on Carey Act–sponsored agricultural activities in the region. This act, which was passed in 1894, was designed to aid in the reclamation (through irrigation) and settlement of desert lands. In addition, six historic structures associated with INTEC have been identified. An historic resource inventory of all buildings within INTEC is being conducted and will likely identify additional historic structures built between 1949 and 1974 (Abbott, Crockett, and Moor 1997:16).

TEST REACTOR AREA

All three of the major reactors within the Test Reactor Area (the Materials Test Reactor, the Engineering Test Reactor, and ATR), along with numerous support facilities, are considered eligible for listing on the National Register of Historic Places. As a result of an historic building inventory conducted in 1997, 59 Test Reactor Area buildings are considered to be eligible for the National Register (Moor and Peterson 1999:13).

3.3.7.3 Native American Resources

Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. In addition, cultural values are placed on natural resources such as plants, which have multiple purposes within various Native American groups. Of primary concern are concepts of sacred space that create the potential for land use conflicts.

3.3.7.3.1 General Site Description

Native American resources at INEEL are associated with the two groups of nomadic hunters and gatherers that used the region at the time of European-American contact: the Shoshone and Bannock. Both of these groups used the area that now encompasses INEEL, as they harvested plant and animal resources and obsidian from Big Southern Butte and Howe Point. Because INEEL is considered part of the Shoshone-Bannock Tribes' ancestral homeland, it contains many localities that are important for traditional, cultural, educational, and religious reasons. This includes not only prehistoric archaeological sites which are important in a religious or cultural heritage context, but also includes features of the natural landscape and air, plant, water, and animal resources that have special significance. Consultation has been initiated with the Shoshone and Bannock Tribes.

3.3.7.3.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

Although INTEC and the surrounding area may contain Native American resources (Abbott, Crockett, and Moor 1997:16), it is unlikely that undisturbed Native American resources exist within the fenced perimeter of the site.

TEST REACTOR AREA

Over the past two decades, efforts have been underway to assemble complete inventories of cultural resources in the vicinity of major operating facilities at INEEL. A variety of survey projects have been completed near the Test Reactor Area, including a 1984 examination of a 100-meters-wide (328-foot-wide) corridor surrounding the fenced perimeter of the site. No Native American resources were identified within the surveyed area, and it is unlikely that undisturbed Native American resources are present within the fenced perimeter of the Test Reactor Area, although no specific surveys have been conducted. Cultural resource surveys in the vicinity of the Test Reactor Area have identified small Native American campsites, and an area that may be of traditional and cultural importance to the Shoshone-Bannock Tribes (Moor and Peterson 1999:12).

3.3.7.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. Paleontological remains consist of fossils and their associated geologic information.

3.3.7.4.1 General Site Description

The region encompassing INEEL has abundant and varied paleontological resources, including plant, vertebrate, and invertebrate remains in soils, lake and river sediments, and organic materials found in caves and archaeological sites. Vertebrate fossils recovered from the Big Lost River floodplain consist of isolated bones and teeth from large mammals of the Pleistocene or Ice Age. These fossils were discovered during excavations and well drilling operations. Fossils have been recorded in the vicinity of the Naval Reactors Facility. Occasional skeletal elements of fossil mammoth, horse, and camel have been retrieved from the Big Lost River diversion dam and Radioactive Waste Management Complex on the southwestern side of INEEL, and from river and alluvial fan gravels and Lake Terreton sediments near Test Area North (DOE 1999e). In total, 24 paleontological localities have been identified in INEEL (Miller 1995).

3.3.7.4.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

Vertebrate fossils recovered from the Big Lost River floodplain consist of isolated bones or teeth from large mammals of the Pleistocene or Ice Age. These fossils were discovered during excavations and well-drilling operations. A single mammoth tooth was salvaged during the excavation of a percolation pond located to the south of INTEC (Abbott, Crockett, and Moor 1997:16).

TEST REACTOR AREA

A mammoth tooth dating from the late Pleistocene has been recovered from the Test Reactor Area (Miller 1995:J-15).

3.3.8 Socioeconomics

Statistics for employment and regional economy are presented for the regional economic area, as defined in Appendix G.8, which encompasses 13 counties around INEEL located in Idaho and Wyoming. Statistics for population, housing, community services, and local transportation are presented for the region of influence, a four-county area in Idaho in which 94.4 percent of all INEEL employees reside, as shown in **Table 3–14**. In 1997, INEEL employed 8,291 persons (about 5.5 percent of the regional economic area civilian labor force) (DOE 1999e).

Table 3–14 Distribution of Employees by Place of Residence in the INEEL Region of Influence, 1997

County	Number of Employees	Total Site Employment (percent)
Bonneville	5,553	67.0
Bingham	1,077	13.0
Bannock	615	7.4
Jefferson	583	7.0
Region of influence total	7,828	94.4

Source: DOE 1999e.

3.3.8.1 Regional Economic Characteristics

Between 1990 and 1996, the civilian labor force in the regional economic area increased 26 percent, to the 1996 level of 150,403. In 1996, the annual unemployment average in the regional economic area was 4.8 percent, which was slightly less than the annual unemployment average for Idaho (5.2 percent) and Wyoming (5.0 percent) (DOE 1999e).

In 1995, service activities represented the largest sector of employment in the regional economic area (27.1 percent). This was followed by retail trade (20.4 percent), and government (19.5 percent). The totals for these employment sectors in Idaho were 21.5 percent, 19.6 percent, and 18.7 percent, respectively. The totals for these employment sectors in Wyoming were 21.1 percent, 20.8 percent, and 25 percent, respectively (DOE 1999e).

3.3.8.2 Population and Housing

In 1996, the region of influence population totaled 213,547. Between 1990 and 1996, the region of influence population increased by 10.6 percent, compared to a 17.5 percent increase in Idaho's population. Between 1980 and 1990, the number of housing units in the region of influence increased by 6.7 percent, compared to a 10.2 percent increase in Idaho. The total number of housing units in the region of influence in 1990 was 69,760. The 1990 region of influence homeowner vacancy rate was 2.1 percent, compared to the Idaho's rate of 2 percent. The region of influence rental vacancy rate was 8.3 percent compared to Idaho's rate of 7.3 percent (DOE 1999e).

3.3.8.3 Community Services

3.3.8.3.1 Education

In 1997, thirteen school districts providing public education in the INEEL region of influence were operating at capacities between 50 percent and 100 percent. Total student enrollment in the region of influence in 1997 was 50,168, and the student-to-teacher ratio in the region of influence averaged 18.8:1. In 1990, Idaho's average student-to-teacher ratio was 12.8:1 (DOE 1999e).

3.3.8.3.2 Public Safety

In 1997, a total of 475 sworn police officers served the four-county region of influence. In 1997, the average region of influence officer-to-population ratio was 2.2 officers per 1,000 persons, compared to the 1990 state average of 1.6 officers per 1,000 persons. In 1997, 560 paid and volunteer firefighters provided fire protection services in the INEEL region of influence. The region of influence firefighter-to-population ratio in 1997 was 2.6 firefighters per 1,000 persons, compared to the 1990 state average of 1.2 firefighters per 1,000 persons (DOE 1999e).

3.3.8.3.3 Health Care

In 1996, a total of 329 physicians served the region of influence. The average region of influence physician-to-population ratio was 1.5 physicians per 1,000 persons, compared to the 1996 state average of 1.7 physicians per 1,000 persons. In 1997, there were five hospitals serving the four-county region of influence. The hospital bed-to-population ratio was 4.6 hospital beds per 1,000 persons, compared to the 1990 state average of 3.3 hospital beds per 1,000 persons (DOE 1999e).

3.3.8.4 Local Transportation

Vehicular access to INEEL is provided by U.S. Routes 20 and 26 to the south, and State Routes 22 and 33 to the north. U.S. Routes 20 and 26, and State Routes 22 and 33 all share rights-of-way west of INEEL (Figure 3–3).

There are two road segments that could be affected by the alternatives considered in this NI PEIS; U.S. Route 20 from U.S. Routes 26 and 91 at Idaho Falls to U.S. Route 26 East, and U.S. Routes 20 and 26 from U.S. Route 26 East to State Routes 22 and 33.

There are at least 10 pending projects to be completed by the Idaho Transportation Department that could impact access into INEEL as well as within the INEEL site. The type of work includes laying new base, widening and rehabilitation, and pavement rehabilitation, which are all very extensive. Some projects only include a new seal coat, which can be completed in 2 weeks. The projects include: (1) a base and resurfacing and minor widening project scheduled for late in the summer of 2000 for U.S. Route 20 from Brunt Road to Cinder Butte Road; (2) a minor widening and pavement rehabilitation for State Highway 22 from the Butte County line to the Clark County line scheduled for October 2000; (3) a minor widening and rehabilitation and base resurfacing project for State Highway 33 on the INEEL site at the Test Reactor Area NE in Jefferson County scheduled for October 2000; (4) a minor widening and restoration and paving rehabilitation project for State Highway 22 on the INEEL site from the junction of State Highway 33 to the Clark County line scheduled for July 2001; (5) a new seal coat will be placed on State Highway 33 at Terreton East and West scheduled after July 2000; (6) a new seal coat for U.S. Route 20 leading into the INEEL site at Arco East scheduled for October 2000; (7) a paving rehabilitation and restoration and new base and resurfacing for State Highway 22 located off site from the Jefferson County line to Mile Post 52.24 scheduled in July 2002; (8) a new seal coat for U.S. Route 20 leading into the site just above the Bonneville County line scheduled for October 2002; (9) a new seal coat for State Highway 22 leading into the site from the junction of State Highway 28 to Medicine Lodge scheduled for July 2003; (10) a new seal coat for State Highway 33 on the INEEL site from Mile Post 38.5 to the junction of State Highway 28 in Jefferson County scheduled for 2003 (Cole 2000).

DOE shuttle vans provide transportation between INEEL facilities and Idaho Falls for DOE and contractor personnel. The major railroad in the region of influence is the Union Pacific Railroad. The railroad's Blackfoot-to-Arco Branch provides rail service to the southern portion of INEEL. A DOE-owned spur connects the Union Pacific Railroad to INEEL by a junction at Scoville Siding. There are no navigable waterways within the region of influence capable of accommodating waterborne transportation of material shipments to INEEL. Fanning Field in Idaho Falls and Pocatello Municipal Airport in Pocatello provide jet air passenger and cargo service for both national and local carriers. Numerous smaller private airports are located throughout the region of influence (DOE 1999e).

3.3.9 Existing Human Health Risk

Existing human health risk issues include the determination of potentially adverse effects on human health that result from acute and chronic exposures to ionizing radiation and hazardous chemicals.

3.3.9.1 Radiation Exposure and Risk

3.3.9.1.1 General Site Description

Major sources and levels of background radiation exposure to individuals in the vicinity of INEEL are shown in **Table 3–15**. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population, in terms of person-rem, changes as the population size changes. Background radiation doses are unrelated to INEEL operations.

Releases of radionuclides to the environment from INEEL operations provide another source of radiation exposure to individuals in the vicinity of INEEL. Types and quantities of radionuclides released from INEEL operations in 1997 are listed in the *Idaho National Engineering and Environmental Laboratory Site Environmental Report for Calendar Year 1997* (Evans et al. 1998:7-4, 7-5). The doses to the public resulting from these releases are presented in **Table 3–16**. These doses fall within radiological limits per DOE Order 5400.5, and are much lower than those of background radiation.

Using a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Appendix H), the risk of a latent cancer fatality to the maximally exposed member of the public due to radiological releases from INEEL operations in 1997 is estimated to be 1.1×10^{-8}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of INEEL operations is less than 2 in 100 million. It takes several to many years from the time of radiation exposure for a cancer to manifest itself.

According to the same risk estimator, 1.2×10^{-4} excess cancer fatality is projected in the population living within 80 kilometers (50 miles) of INEEL from normal operations in 1997. To place this number in perspective, it may be compared with the number of cancer fatalities expected in the same population from all causes. The 1997 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Famighetti 1998:964). Based on this mortality rate, the number of cancer fatalities expected during 1997 from all causes in the population living within 80 kilometers (50 miles) of INEEL was 243. This expected number of cancer fatalities is much higher than the 1.2×10^{-4} cancer fatality estimated from INEEL operations in 1997.

INEEL workers receive the same doses as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. The average dose to the individual worker and the cumulative dose to all workers at INEEL from operations in 1997 are presented in **Table 3–17**. These doses fall within the radiological regulatory limits of 10 CFR Section 835.202. According to a risk estimator of 400 cancer fatalities per 1 million person-rem among workers (Appendix H), the number of projected latent cancer fatalities among INEEL workers from normal operations in 1997 is 0.046.

Table 3–15 Sources of Radiation Exposure to Individuals in the INEEL Vicinity Unrelated to INEEL Operations

Source	Effective Dose Equivalent (millirem per year)
Natural background radiation[a]	
Cosmic radiation	48
External terrestrial radiation	74
Internal terrestrial/cosmogenic radiation	40
Radon in homes (inhaled)	200
Other background radiation[b]	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	Less than 1
Air travel	1
Consumer and industrial products	10
Total	427

a. Evans et al. 1998:4-19.
b. NCRP 1987:11, 40, 53.
Note: Value of radon is an average for the United States.

Table 3–16 Radiation Doses to the Public from INEEL Normal 1997 Operations (Total Effective Dose Equivalent)

Members of the Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**
Maximally exposed individual (millirem)	10	0.021	4	0	100	0.021
Population within 80 kilometers (person-rem)[b]	None	0.23	None	0	100	0.23
Average individual within 80 kilometers (millirem)[c]	None	0.0019	None	0	None	0.0019

a. The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10-millirem-per-year limit from airborne emissions is required by the Clean Air Act, and the 4-millirem-per-year limit is required by the Safe Drinking Water Act; for this NI PEIS, the 4-millirem-per year value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. The total dose of 100 millirem per year is the limit from all pathways combined. The 100-person-rem value for the population is given in proposed 10 CFR Part 834, as published in 58 FR 16268. If the potential total dose exceeds the 100-person-rem value, it is required that the contractor operating the facility notify DOE.
b. Based on a population of about 121,400 in 1997.
c. Obtained by dividing the population dose by the number of people living within 80 kilometers (50 miles) of the site.
Source: Evans et al. 1998.

Table 3–17 Radiation Doses to Workers from INEEL Normal 1997 Operations (Total Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	**Actual**
Average radiation worker (millirem)	None[b]	101[c]
Total workers (person-rem)[d]	None	115[c]

a. The radiological limit for an individual worker is 5,000 millirem per year. However, DOE's goal is to maintain radiological exposure as low as is reasonably achievable. It has therefore established the Administrative Control Level of 2,000 millirem per year; the site must make reasonable attempts to maintain individual worker doses below this level.
b. No standard is specified for an "average radiation worker;" however, the maximum dose that this worker may receive is limited to that given in footnote "a."
c. Does not include doses received at the Naval Reactors Facility. The impacts associated with this facility fall under the jurisdiction of the Navy as part of the Nuclear Propulsion Program.
d. Based on a worker population of 1,141 with measurable doses in 1997.
Source: DOE 1999d; 10 CFR Section 835.202.

A more detailed presentation on the radiation environment, including background exposures and radiological releases and doses, is presented in the *Idaho National Engineering and Environmental Laboratory Site Environmental Report for Calendar Year 1997* (Evans et al. 1998). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (on and off site) are also presented in that report.

3.3.9.1.2 Locations of Proposed Activities

IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER

External radiation doses and concentrations of gross alpha and beta in air have been measured in the vicinity of INTEC. In 1997, the annual average dose within INTEC was about 170 millirem. This is about 31 millirem higher than the average dose measured at the offsite control locations. This onsite dose would affect workers only and is well below annual worker dose limits as identified in Table 3–17. Concentrations in air of gross alpha and beta were 6.0×10^{-16} microcuries per milliliter and 1.9×10^{-14} microcuries per millilter, respectively (Evans et al. 1998:4-4, 4-5, 4-22, 4-26).

TEST REACTOR AREA

External radiation doses and concentrations of gross alpha and beta in air have been measured in the vicinity of the Test Reactor Area. In 1997, the annual average dose within the Test Reactor Area was about 190 millirem. This onsite dose would affect workers only and is well below annual worker dose limits as identified in Table 3–17. This is about 50 millirem higher than the average dose measured at the offsite control locations. Concentrations in air of gross alpha and beta were 8.0×10^{-16} microcuries per milliliter and 2.3×10^{-14} microcuries per milliliter, respectively (Evans et al. 1998:4-4, 4-5, 4-25, 4-26).

3.3.9.2 Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media through which people may come in contact with hazardous chemicals (e.g., surface water during swimming, soil through direct contact, or food). Hazardous chemicals can cause cancer and other adverse health effects.

Carcinogenic Effects. Health effects in this case are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. This could be incremental or excess individual lifetime cancer risk.

Noncarginogenic Effects. Health effects in this case are determined by the ratio between the calculated, or measured concentration of the chemical in the air and the reference concentration or dose. This ratio is known as the Hazard Quotient. Hazard Quotients for noncarcinogens are summed to obtain the Hazard Index. If the Hazard Index is less than 1, no adverse health effects would be expected.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., air emissions and NPDES permit requirements) contribute to minimizing health impacts on the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts on the public may occur through inhaling air containing hazardous chemicals released to the atmosphere during normal INEEL operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are lower than those via the inhalation pathway. At INEEL, the risk to public health from water ingestion and direct exposure pathways is low because surface water is not used for drinking or as a receptor for wastewater discharges.

Baseline air emission concentrations and applicable standards for hazardous chemicals are addressed in Section 3.3.3.

The baseline concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information on estimating the health impacts of hazardous chemicals is presented in Appendix H.

Exposure pathways to INEEL workers during normal operations may include inhaling contaminants in the workplace atmosphere and direct contact with hazardous materials. The potential for health impacts varies among facilities and workers, and available information is insufficient for a meaningful estimate of impacts. However, workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, substitution, and engineering and management controls. INEEL workers are also protected by adherence to OSHA and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals used in the operational processes ensures that these standards are not exceeded. Additionally, DOE requires that conditions in the workplace be as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm.

3.3.9.3 Health Effects Studies

Epidemiological studies were conducted on communities surrounding INEEL to determine whether there are excess cancers in the general population. Two of these are described in more detail in Appendix M.4.4 of the *Storage and Disposition PEIS* (DOE 1996b:M-233, M-234). No excess cancer mortality was reported, and although excess cancer incidence was observed, no association thereof with INEEL was established. A study by the State of Idaho completed in June 1996, found excess brain cancer incidence in the six counties surrounding INEEL, but a follow-up survey concluded that “No common factors were identified that clearly linked the cases, and individuals expressed varying concerns about possible exposures or causes for brain cancer” (ID DHW 1997).

No occupational epidemiological studies have been completed at INEEL to date, but several worker health studies have been initiated recently at INEEL. Researchers from the Boston University School of Public Health, in cooperation with the National Institute of Occupational Safety and Health, are investigating the effects of workforce restructuring (downsizing) in the nuclear weapons industry. The health of displaced workers will be studied. Under a National Institute of Occupational Safety and Health cooperative agreement, the epidemiologic evaluation of childhood leukemia and paternal exposure to ionizing radiation now includes INEEL as well as other DOE sites. Another study, begun in October 1997, *Medical Surveillance for Former Workers at INEEL*, is being carried out by a group of investigators from the Oil, Chemical, and Atomic Workers International Union, Mt. Sinai School of Medicine, the University of Massachusetts at Lowell, and the Alice Hamilton College. DOE has implemented an epidemiologic surveillance program to monitor the health of current INEEL workers. A discussion of this program is given in Appendix M.4.4 of the *Storage and Disposition PEIS* (DOE 1996b:M-233, M-234).

3.3.9.4 Accident History

DOE conducted a study, the *Idaho National Engineering Laboratory Historical Dose Evaluation* (DOE 1991), to estimate the potential offsite radiation doses for the entire operating history of INEEL (DOE 1996b:3-139).

Releases resulted from a variety of tests and experiments as well as a few accidents at INEEL. The study concluded that these releases contributed to the total radiation dose during test programs of the 1950s and early 1960s. The frequency and size of releases have declined since that time. There have been no serious unplanned or accidental releases of radioactive or other hazardous substances at INEEL facilities in the 10 years of operation prior to 1998. However, in July 1998, an incident occurred at INEEL's Test Reactor Area. One fatality and several injuries resulted from an accidental release of fire retardant carbon dioxide during routine maintenance operation. No nuclear materials were involved and there was no threat to public safety (DOE 1998a, 1998b, 1998c, 1998d).

3.3.9.5 Emergency Preparedness

Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program includes emergency planning, preparedness, and response.

Government agencies whose plans are interrelated with the INEEL emergency plan for action include the State of Idaho, Bingham County, Bonneville County, Butte County, Clark County, Jefferson County, the Bureau of Indian Affairs, and the Fort Hall Indian Reservation. INEEL contractors are responsible for responding to emergencies at their facilities. Specifically, the emergency action director is responsible for recognition, classification, notification, and protective action recommendations. At INEEL, emergency preparedness resources include fire protection from onsite and offsite locations and radiological and hazardous chemical material response. Emergency response facilities include an emergency control center at each facility, the INEEL Warning Communication Center, and the INEEL site Emergency Operations Center. Seven INEEL medical facilities are also available to provide routine and emergency service.

DOE has specified actions to be taken at all DOE sites, implementing lessons learned from the emergency response to an accidental explosion at Hanford in May 1997.

3.3.10 Environmental Justice

Under Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, Federal agencies are responsible for identifying and addressing the possibility of disproportionately high and adverse health, economic, and environmental impacts of programs and activities on minority and low-income populations in potentially affected areas. Minority populations refer to persons of any race self-designated as Asian, Black, Native American, or Hispanic. Low-income populations refer to households with incomes below the Federal poverty thresholds. In the case of INEEL, the potentially affected area includes only parts of central Idaho.

The potentially affected area surrounding ATR is defined by a circle with an 80-kilometer (50-mile) radius centered at the Test Reactor Area (latitude 43° 35'8" N, longitude 112° 57'47" W). The total population residing within that area in 1990 was 105,939. Minorities made up 10.1 percent of the total population. In 1990, approximately one-fourth of the total population was comprised of persons self-designated as members of a minority group; minorities made up 7.8 percent of the State of Idaho's total population.

At the time of the 1990 census, Hispanics and Native Americans were the largest minority groups within the potentially affected area, accounting for 6.2 percent and 2.7 percent of the total population, respectively. Asians constituted about 1.1 percent, and Blacks, about 0.3 percent (DOC 1992).

In 1990, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 13,188 persons (12.6 percent of the total population) residing within the potentially affected area around ATR reported incomes below that threshold (DOC 1992). Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold. The corresponding percentage for Idaho was 13.3 percent

The potentially affected area surrounding FDPF is defined by an 80-kilometer (50-mile) circle centered at INTEC (latitude 43° 34′12.5″ N, longitude 112° 55′55.4″ W). The total population residing within the potentially affected area in 1990 was 121,472. Approximately 10 percent of the total population was comprised of person self-designated as members of a minority. Data from the1990 census show that minorities represented approximately 24 present of the national population, and approximately 8 percent of the population of the State of Idaho. Hispanics (6.2 percent) and Native Americans (2.7 percent) were the largest minority groups within the population at risk. Asians (1.1 percent) and Blacks (0.3 percent) made up the remainder of the minority population at risk. Approximately 12 percent of the population at risk reported incomes below the poverty threshold of 1990.

3.3.11 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE activities. The waste is managed using appropriate treatment, storage, and disposal technologies, and in compliance with all applicable Federal and state statutes and DOE orders.

3.3.11.1 Waste Inventories and Activities

INEEL manages the following types of waste: high-level radioactive, transuranic, mixed transuranic, low-level radioactive, mixed low-level radioactive, hazardous, and nonhazardous. Waste generation rates and the inventory of stored waste from activities at INEEL are provided in **Table 3–18**. Although high-level radioactive waste would not be generated by the proposed plutonium-238 production, new medical and industrial isotope production, or new nuclear research and development activities at INTEC, it is included in this table and discussed in this section because the transuranic waste that would be generated may be managed as high-level radioactive waste. The INEEL waste management capabilities are summarized in **Table 3–19**. More detailed descriptions of the waste management system capabilities at INEEL are included in the *Storage and Disposition PEIS* (DOE 1996b:3-141–145, E-33–E-48) and the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995a:2.2-30).

EPA placed INEEL on the National Priorities List on December 21, 1989. In accordance with CERCLA, DOE entered into a consent order with EPA and the State of Idaho to coordinate cleanup activities at INEEL under one comprehensive strategy. This agreement integrates DOE's CERCLA response obligations with RCRA corrective action obligations. Aggressive plans are in place to achieve early remediation of sites that represent the greatest risk to workers and the public. The goal is to complete remediation of contaminated sites at INEEL to support delisting from the National Priorities List by 2019 (DOE 1996b:3-141). More information on regulatory requirements for waste disposal is provided in Chapter 5.

3.3.11.2 High-Level Radioactive Waste

High-level radioactive waste at INEEL was generated in the process of extracting useful isotopes from spent nuclear fuel at INTEC. Most of this fuel was from the Naval Reactors Program. Most aqueous solutions from spent nuclear fuel processing and isotope extraction were concentrated by evaporation and separated into low-level and high-level radioactive waste streams in the Process Equipment Waste Evaporator. The liquid high-

Table 3–18 Waste Generation Rates and Inventories at INEEL

Waste Type	Generation Rate (cubic meters per year)	Inventory (cubic meters)
High-level radioactive	0[a]	4,200[b]
Transuranic and mixed transuranic	0[a, c]	65,000[d, e]
Sodium bearing waste	0[a]	5,300[b]
Low-level radioactive	6,400[f]	6,000[g]
Mixed low-level radioactive[h]	230	1,700
Hazardous	835[c, i]	NA[j]
Nonhazardous		
Liquid	2,000,000[c, k]	NA[j]
Solid	62,000[c]	NA[j]

a. Refer to the text.
b. DOE 1999i. The sodium-bearing waste is managed by the high-level radioactive waste program.
c. Moor and Peterson 1999:chap. 3.
d. Includes both alpha low-level radioactive waste and transuranic waste.
e. DOE 1995a:4.14-2.
f. Willson 1998:2-9 and 2-10.
g. Bright 1999.
h. DOE 1998e:4-5.
i. Includes 760 cubic meters that is recyclable.
j. Generally, hazardous and nonhazardous wastes are not held in long-term storage.
k. Projected annual average generation amounts for 1997–2006.
Note: To convert from cubic meters to cubic yards, multiply by 1.308.
Key: NA, not applicable.

level radioactive waste was stored in subsurface tanks and then transformed by calcination into solid metallic oxides in a granular form. This calcination was completed in February 1998. The calcine is stored in stainless steel bins in near-surface concrete vaults where it awaits further processing into a form suitable for emplacement in a Federal repository. INEEL met the requirements of a December 1991 consent order with the State of Idaho and EPA to calcine all the high-level radioactive waste by June 30, 1998. Subsequently, the calcined waste will be treated to meet RCRA provisions on a schedule to be negotiated with the State of Idaho under the Federal Facility Compliance Act.

Although sodium-bearing waste is not high-level radioactive waste as specified in the Nuclear Waste Policy Act of 1982, it has been historically managed as high-level waste at INEEL. This is because some of the physical and chemical properties of these two waste types are similar (e.g., both are acidic and both contain similar radionuclides, including transuranics) (DOE 1999i:1-11). About 5,300 cubic meters (1.4×10^6 gallons) of liquid-sodium-bearing waste remain in the INTEC Tank Farm. New treatment processes for the remaining liquid-sodium-bearing wastes are being analyzed in the *Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement*.

3.3.11.3 Transuranic and Mixed Transuranic Waste

Transuranic waste generated since 1972 is segregated into contact-handled and remotely handled categories and stored at the Radioactive Waste Management Complex in a form designed for eventual retrieval (DOE 1996b:3-144). Some transuranic waste is also stored at the Radioactive Scrap and Waste Facility at ANL–W (DOE 1995a:2.2-36). There is virtually no transuranic waste generated at INEEL. Most of the transuranic waste in storage was received from the Rocky Flats Environmental Technology Site (DOE 1996b:3-144). Transuranic waste is currently being stored, pending shipment to WIPP. Transuranic waste will be treated to meet WIPP waste acceptance criteria, packaged in accordance with DOE and Department of Transportation (DOT) requirements, and transported to WIPP for disposal (DOE 1996b:3-144)

Table 3–19 Waste Management Capabilities at INEEL

Facility Name/Description	Capacity	Status	Applicable Waste Type HLW	TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
Treatment Facility (cubic meters per year except as otherwise specified)									
INTEC HEPA Filter Leach, cubic meters per day	0.21	Online			X		X		
INTEC Debris Treatment and Containment, cubic meters per day	88	Waiting on Part B Permit			X		X		
Advanced Mixed Waste Treatment Project	6,500	Planned for 2003			X		X		
INTEC NWCF	248	Standby[a]	X		X				
ANL–W Remote Treatment Facility	42	Planned for 2000		X	X	X	X		
ANL–W HFEF Waste Characterization Area	37	Online		X	X				
INTEC Waste Immobilization Facility	48	Planned for 2008	X						
INTEC Liquid Effluent Treatment and Disposal Facility	11,365	Online					X		
INTEC High-Level Radioactive Waste Evaporator	6,138	Online			X		X		
INTEC Process Equipment Waste Evaporator (PEW)	13,000	Online			X	X	X		
ANL–W Sodium Processing Facility	698	Online					X		
Test Area North Cask Dismantlement	11	Online					X		
Test Reactor Area Evaporation Pond, cubic meters per day	820	Online				X			
WROC - Debris Sizing, kilograms per hour	1,149	Planned for 2000				X	X		
WROC - Macroencapsulation, kilograms per hour	2,257	Planned for 2001					X		
WROC - Stabilization, cubic meters per day	7.6	Online					X		
WERF	49,610	Online				X	X	X	
INTEC Sewage Treatment Plant	3,200,000	Online							X
Storage Facility (cubic meters)									
INTEC Calcine Bin Sets	6,950	Online	X						
ANL–W Radioactive Sodium Storage	75	Online			X		X		
ANL–W Sodium Components Maintenance Shop	200	Online					X		
ANL–W Radioactive Scrap and Waste Storage	193	Online		X	X	X	X		

Facility Name/Description	Capacity	Status	Applicable Waste Type						
			HLW	**TRU**	**Mixed TRU**	**LLW**	**Mixed LLW**	**Haz**	**Non-Haz**
ANL–W EBR II Sodium Boiler Drain Tank	64	Online					X		
ANL–W HFEF Waste Characterization Area	37	Online		X	X				
INTEC Tank Farm	12,533	Online	X[b]		X				
INTEC FDP HEPA Storage	25	Online			X		X		
INTEC NWCF HEPA Storage	56	Online			X		X		
INTEC CPP-1619 Storage	45	Online					X	X	
INTEC CPP-1617 Staging	8,523	Online					X	X	
RWMC Transuranic Storage Area-RE[c]	64,900	Online		X	X	X	X		
RWMC Waste Storage[c]	112,400	Online		X	X	X	X		
RWMC Intermediate-Level Storage	100	Online		X					
WROC PBF Mixed Low-level Radioactive Waste Storage	129	Online					X	X	
Portable Storage at SPERT IV	237	Online					X	X	
PBF WERF Waste Storage Building	685	Online					X	X	
Test Area North 647 Waste Storage	104	Online					X		
Test Area North 628 SMC Container Storage	125	Online					X		
Disposal Facility (cubic meters per year)									
RWMC Disposal Facility	37,700	Online				X			
CFA Landfill Complex	48,000	Online							X
Percolation Ponds	2,000,000	Online							X
FPF Sanitary Sewer	166,000	Online							X

a. NWCF was shut down on June 1, 2000 and is in standby pending facility upgrades and issuance of a new air permit.
b. Sodium-bearing waste is managed by the high-level radioactive waste program.
c. For these facilities, the low-level radioactive and mixed low-level radioactive wastes are considered alpha-contaminated low-level radioactive waste and alpha-contaminated mixed low-level radioactive waste (waste containing between 10 and 100 nanocuries of alpha activity per gram).

Note: To convert from cubic meters to cubic yards, multiply by 1.308.

Key: ANL–W, Argonne National Laboratory–West; CFA, Central Facilities Area; CPP, Chemical Processing Plant; EBR, Experimental Breeder Reactor; FDPF, Fluorinel Dissolution Process Facility; FPF, Fuel Processing Facility; Haz, hazardous; HEPA, high-efficiency particulate air; HFEF, Hot Fuel Examination Facility; HLW, high-level radioactive waste; INTEC, Idaho Nuclear Technology and Engineering Center; LLW, low-level radioactive waste; NWCF, New Waste Calcining Facility; PBF, Power Burst Facility; RWMC, Radioactive Waste Management Complex; SMC, Specific Manufacturing Complex; SPERT, Special Power Excursion Reactor Test; TRU, transuranic waste, WERF, Waste Experimental Reduction Facility; WROC, Waste Reduction Operations Complex.

Source: DOE 1999e:3-54 and 3-55; Depperschmidt 1999.

or a suitable geologic repository. The first shipment of transuranic waste from INEEL was received at WIPP on April 28, 1999 (DOE 1999j).

The existing treatment facilities for transuranic waste at INEEL are limited to testing, characterization, and repackaging. The Advanced Mixed Waste Treatment Project will be operated as a private sector treatment facility after its construction is completed (Moor and Peterson 1999). This facility will (1) treat waste to meet WIPP waste acceptance criteria, RCRA Land Disposal Restrictions, and required Toxic Substances Control Act standards; (2) reduce waste volume and life-cycle cost to DOE; and (3) perform tasks in a safe and environmentally compliant manner (Mitchell et al. 1996b:3-16). The construction of the incinerator component of this facility has been deferred, pending the recommendation of a blue ribbon panel of experts. This panel of experts will assess and recommend new technology alternatives to incineration. The panel's recommendation is expected in December 2000 (DOE 2000b).

Waste containing between 10 and 100 nanocuries of alpha activity per gram of transuranic radionuclides is called alpha low-level radioactive waste. Although this waste is technically considered low-level radioactive waste rather than transuranic waste, it cannot be disposed of at INEEL because it does not meet all of the INEEL low-level radioactive waste disposal facility acceptance criteria. Alpha low-level radioactive waste and alpha mixed low-level radioactive waste are managed together as part of the transuranic waste program. It is expected that these wastes will be treated by the Advanced Mixed Waste Treatment Project and then be disposed of at WIPP (DOE 1995a:2.2-34, 2.2-35).

3.3.11.4 Low-Level Radioactive Waste

Liquid low-level radioactive waste is solidified before disposal (DOE 1996b:E-35). INTEC has the capability to treat aqueous low-level radioactive waste. Liquid low-level radioactive waste is concentrated at the INTEC Process Equipment Waste Evaporator, with the condensed vapor processed by the Liquid Effluent Treatment and Disposal Facility. The concentrated materials remaining after evaporation are stored in the Chemical Processing Plant–604 storage tanks. Some small volumes of liquid low-level radioactive waste are solidified at the Waste Experimental Reduction Facility for disposal at the Radioactive Waste Management Complex. Currently, the Waste Experimental Reduction Facility is scheduled to be shutdown by September 2001. In addition, aqueous low-level radioactive waste are discharged to the two double-lined ponds at the Test Reactor Area for evaporation (DOE 1995a:2.2-39).

Most solid low-level radioactive waste at INEEL is sent to the Waste Experimental Reduction Facility for treatment by incineration, compaction, size reduction, or stabilization before shipment for disposal at the Radioactive Waste Management Complex or offsite disposal facilities (Werner 1997). Disposal occurs in pits and concrete-lined soil vaults in the subsurface disposal area of the Radioactive Waste Management Complex (DOE 1995a:2.2-39). Approximately 60 percent of the low-level radioactive waste generated at INEEL is treated for volume reduction prior to disposal at the Radioactive Waste Management Complex. Additionally, some low-level radioactive waste is shipped off site to be incinerated, and the residual ash is returned to INEEL for disposal. The Radioactive Waste Management Complex is expected to be filled to capacity by the year 2030 (Mitchell et al. 1996b:3-26), although some proposals would close the low-level radioactive waste disposal facility by 2006 (DOE 1998f:B-4).

3.3.11.5 Mixed Low-Level Radioactive Waste

Mixed low-level radioactive waste is divided into two categories for management purposes: alpha mixed low-level radioactive waste and beta-gamma mixed low-level radioactive waste. Most of the alpha mixed low-level radioactive waste stored at INEEL is waste that has been reclassified from mixed transuranic waste and is managed as part of the transuranic waste program. Therefore, this section deals only with beta-gamma mixed low-level radioactive waste (DOE 1995a:2.2-39, 2.2-40).

Mixed low-level radioactive waste, including polychlorinated biphenyl–contaminated low-level radioactive waste, is stored at several onsite areas awaiting the development of treatment methods (DOE 1996b:3-144). Mixed low-level radioactive waste is stored at the Mixed Waste Storage Facility (or Waste Experimental Reduction Facility Waste Storage Building) and in portable storage units at the Power Burst Facility area. In addition, smaller quantities of mixed low-level radioactive waste are stored in various facilities at INEEL, including the Hazardous Chemical/Radioactive Waste Facility at INTEC, and the Radioactive Sodium Storage Facility and Radioactive Scrap and Waste Storage Facility at Argonne National Laboratory–West (DOE 1995a:2.2-41). Although mixed wastes are stored in many locations at INEEL, the bulk of that volume is solid waste stored at the Radioactive Waste Management Complex (DOE 1996b:E-38).

As part of the INEEL Site Treatment Plan and Consent Order required by the Federal Facility Compliance Act, preferred treatment options have been identified to eliminate the hazardous waste component for many types of mixed low-level radioactive waste (DOE 1995a:2.2-42). Mixed low-level radioactive waste is or will be processed to RCRA Land Disposal Restrictions treatment standards through several treatment facilities. Those treatment facilities and their operational status are: (1) Waste Experimental Reduction Facility Incinerator (operational), (2) Waste Experimental Reduction Facility Stabilization (operational), (3) Test Area North cask dismantlement (operational), (4) Sodium Process Facility (operational), (5) High-Efficiency Particulate Air Filter Leach (operational), (6) Waste Reductions Operations Complex Macroencapsulation (March 2001), (7) Debris Treatment (September 2000), and (8) Advanced Mixed Waste Treatment Project (March 2003). Commercial treatment facilities are also being considered, as appropriate. Currently, limited amounts of mixed low-level radioactive waste are disposed of at Envirocare of Utah (DOE 1999e:3-57).

3.3.11.6 Hazardous Waste

Approximately 1 percent of the total waste generated at INEEL (not including liquid nonhazardous waste) is hazardous waste. Most of the hazardous waste generated annually at INEEL is transported off site for treatment and disposal (DOE 1995a:2.2-45). Offsite shipments are surveyed to determine that the wastes have no radioactive content, and therefore are not mixed waste (DOE 1996b:3-145).

Highly reactive or unstable materials, such as waste explosives, are addressed on a case-by-case basis, and are either stored, burned, or detonated, as appropriate. The Waste Handling Facility Project at Argonne National Laboratory–West will be implemented to handle Argonne National Laboratory–West hazardous waste (DOE 1996b).

3.3.11.7 Nonhazardous Waste

Approximately 90 percent of the solid waste generated at INEEL is classified as industrial waste and is disposed of on site in a landfill complex in the Central Facilities Area and off site at the Bonneville County landfill (DOE 1995a:2.2-47). The onsite landfill complex contains separate areas for petroleum-contaminated media, industrial waste, and asbestos waste (Werner 1997). The onsite landfill is 4.8 hectares (12 acres), and is being expanded by 91 hectares (225 acres) to provide capacity for at least 30 years (DOE 1996b:3-145).

Sewage is disposed of in surface impoundments in accordance with terms of the October 7, 1992 Consent Order. Waste in the impoundments is allowed to evaporate, and the resulting sludge is placed in the landfill. Solids are separated and reclaimed where possible (DOE 1996b:3-145). Nonhazardous service wastewater generated at INTEC is disposed of in percolation ponds at a flow rate of 3.8 million to 7.6 million liters (1 million to 2 million gallons) per day (Werner 1997). The INTEC sanitary sewer system collects and transfers sanitary waste to the sewage treatment lagoons east of INTEC for treatment and disposal. This system has a capacity of 3,200,000 cubic meters (4,190,000 cubic yards) per year (DOE 1999e:3-58).

3.3.11.8 Waste Minimization

The DOE Idaho Operations Office has an active waste minimization and pollution prevention program to reduce the total amount of waste generated and disposed of at INEEL. This is accomplished by eliminating waste through source reduction or material substitution; by recycling potential waste materials that cannot be minimized or eliminated; and by treating all waste that is generated to reduce its volume, toxicity, or mobility prior to storage or disposal. The Idaho Operations Office published its first Waste Minimization Plan in 1990, which defined specific goals, methodology, responsibility, and achievements of programs and organizations. The achievements and progress have been updated at least annually. Implementing pollution prevention projects reduced the total amount of waste generated at INEEL in 1998 by approximately 1,100 cubic meters (1,400 cubic yards). Examples of pollution prevention projects completed in 1998 at INEEL include: reduction of routine operations hazardous waste by approximately 55 metric tons (61 tons) by collecting engine oil by a recycling vendor for energy recovery; reducing cleanup/stabilization of hazardous waste by approximately 20 metric tons (22 tons) by dismantling the Mobile Test Assembly Cask and sending the clean lead to the clean lead storage area for recycling; and reducing both routine operations and cleanup/stabilization low-level radioactive waste by approximately 19 cubic meters (25 cubic yards) by recycling depleted uranium scrap metal from both normal facility operations and deactivation of a facility (DOE 1999f:44).

3.3.11.9 Waste Management PEIS Records of Decision

The *Waste Management PEIS* Records of Decision affecting INEEL are shown in **Table 3–20** for the waste types analyzed in this NI PEIS. Decisions on the various waste types were announced in a series of Records of Decisions that have been issued on the *Waste Management PEIS*. The transuranic waste Record of Decision was issued on January 20, 1998 (63 FR 3629); the hazardous waste Record of Decision was issued on August 5, 1998 (63 FR 41810); the high-level radioactive waste Record of Decision was issued on August 12, 1999 (64 FR 46661); and the low-level radioactive and mixed low-level radioactive waste Record of Decision was issued on February 18, 2000 (65 FR 10061). The transuranic waste Record of Decision states that DOE will develop and operate mobile and fixed facilities to characterize and prepare transuranic waste for disposal at WIPP. Each DOE site that has or will generate transuranic waste will, as needed, prepare and store its transuranic waste on site. The hazardous waste Record of Decision states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste with ORR and SRS continuing to treat some of their own nonwastewater hazardous waste, on site in existing facilities, where this is economically feasible. The high-level radioactive waste Record of Decision states that immobilized high-level radioactive waste will be stored at the site of generation until transfer to a geologic repository. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision states that for the management of low-level radioactive waste, minimal treatment will be performed at all sites, and disposal will continue, to the extent practicable, on site at INEEL, LANL, ORR, and SRS. In addition, Hanford and the Nevada Test Site will be available to all DOE sites for low-level radioactive waste disposal. Mixed low-level radioactive waste will be treated at Hanford, INEEL, ORR, and SRS, and disposed of at Hanford and the Nevada Test Site. More detailed information concerning DOE's decisions for the future configuration of waste management facilities at INEEL is presented in the high-level radioactive waste, transuranic waste, hazardous waste, and low-level radioactive waste and mixed low-level radioactive waste Records of Decision.

Table 3–20 Waste Management PEIS Records of Decision Affecting INEEL

Waste Type	Preferred Action
High-level radioactive	DOE has decided that INEEL should store its immobilized high-level radioactive waste on site until transfer to a geologic repository.[a]
Transuranic and mixed transuranic	DOE has decided that INEEL should prepare and store its transuranic waste on site pending disposal at WIPP[b] or another suitable geologic repository.
Low-level radioactive	DOE has decided to treat INEEL's low-level radioactive waste on site. INEEL could be selected as one of the regional disposal sites for low-level radioactive waste.[c]
Mixed low-level radioactive	DOE has decided to regionalize treatment of mixed low-level radioactive waste at INEEL.[c] This includes the onsite treatment of INEEL's wastes and could include treatment of some mixed low-level radioactive waste generated at other sites.
Hazardous	DOE has decided to continue to use commercial facilities for treatment of INEEL nonwastewater hazardous waste. DOE will also continue to use onsite facilities for wastewater hazardous waste.[d]

a. From the Record of Decision for high-level radioactive waste (64 FR 46661).
b. From the Record of Decision for transuranic waste (63 FR 3629).
c. From the Record of Decision for low-level radioactive and mixed low-level radioactive waste (65 FR 10061).
d. From the Record of Decision for hazardous waste (63 FR 41810).
Source: 63 FR 3629; 63 FR 41810; 64 FR 46661; 65 FR 10061.

3.4 HANFORD SITE

Hanford, established in 1943 as one of the three original Manhattan Project sites, is located on approximately 148,000 hectares (365,000 acres) in Washington State, just north of Richland. It extends over parts of Adams, Benton, Grant, and Franklin counties. Hanford was a U.S. Government defense materials production site that included nuclear reactor operation, uranium and plutonium processing, storage and processing of spent nuclear fuel, and management of radioactive and hazardous and state dangerous wastes. Present Hanford programs are diversified and include management of radioactive wastes, cleanup of waste sites, soil, and groundwater related to past releases, stabilization and storage of spent nuclear fuel, renewable energy technologies, waste disposal technologies, contamination cleanup, and plutonium stabilization and storage (DOE 1999k). The primary emphasis at the site is on cleanup activities.

Hanford is owned and used primarily by DOE, but portions of it are owned, leased, or administered by other Government agencies. Public access is limited to travel on the Route 4 and Route 10 access roads as far as the Wye Barricade, State Routes 24 and 240, and the Columbia River. By restricting access to the site, the public is buffered from areas formerly used for production of nuclear materials and currently used for waste storage and disposal. Only about 6 percent of the land area has been disturbed and is actively used, leaving mostly vacant land with widely scattered facilities. On June 9, 2000, the President issued a proclamation that established the 78,900-hectare (195,000-acre) Hanford Reach National Monument (65 FR 37253). This proclamation recognizes the unique character and biological diversity of the area, as well as its geological, paleontological, historic, and archaeological significance. The monument includes not only land adjacent to the Columbia River, but also other areas on the Hanford Site as depicted on Figure 3–6. The U.S. Fish and Wildlife Service will manage the monument under existing agreements with DOE. Land within the monument that is not subject to existing agreements will be managed by DOE; however, DOE will consult with the Secretary of the Interior when developing any management plans affecting these lands.

Hanford includes extensive production, service, research, and development areas. Onsite programmatic and general purpose facilities, many of which are inactive, total approximately 799,000 square meters (8.6 million square feet) of space. Fifty-one percent (408,000 square meters [4.4 million square feet]) is general purpose space, including offices, laboratories, shops, warehouses, and other support facilities. The remaining 392,000 square meters (4.2 million square feet) of space are programmatic facilities including processing, evaporation, filtration, waste recovery, waste treatment, waste storage facilities, and research and development laboratories. More than half of the general purpose and programmatic facilities are more than 30 years old. Facilities designed to perform previous missions are being evaluated for reuse in the cleanup mission. The existing facilities are grouped into the following numbered operational areas (DOE 1996b:3-20, 3-21).

The 100 Areas, in the northern part of the site on the southern shore of the Columbia River, are the site of eight retired plutonium production reactors and the dual-purpose N Reactor, all of which have been permanently shut down since 1991. Work is ongoing to place the reactor into a long-term safe storage configuration. Waste sites throughout the 100 Areas are currently undergoing remediation, consisting of excavating contaminated soils and structural materials. Contaminated groundwater in the 100 Areas is being treated via both ex situ and in situ methods. Approximately 2,000 metric tons (2,200 tons) of spent nuclear fuel are currently stored in indoor basins in the 100 Areas pending approval and storage in the 200 Areas. The 100 Areas cover about 1,100 hectares (2,720 acres).

The 200-West and 200-East Areas are in the center of the site and are about 8 and 11 kilometers (5 and 6.8 miles), respectively, south of the Columbia River. The 200-West and 200-East Areas are also about 20 and 12 kilometers (12.2 and 7.3 miles), respectively, west of the Columbia River. Historically, these areas have been used for fuel processing; plutonium processing, fabrication, and storage; and waste management and disposal activities. DOE has constructed the Environmental Restoration Disposal Facility in the 200 Area to provide disposal capacity for environmental remediation waste (e.g., low-level, mixed low-level, and dangerous wastes) generated during remediation of the 100, 200, and 300 Areas of the Hanford Site. The facility currently covers about 130 hectares (320 acres) and can be expanded up to 414 hectares (1,020 acres) as additional waste disposal capacity is required (DOE 1999k). The 200 Areas cover about 1,600 hectares (3,950 acres).

The 300 Area is in the southern part of the site, just north of the city of Richland. A few of the facilities continue to support nuclear and nonnuclear research and development of the Pacific Northwest National Laboratory. Many of the facilities in the 300 Area are in the process of being deactivated. The Environmental Molecular Sciences Laboratory and associated research programs provide research capability to advance technologies in support of DOE's environmental remediation and waste management programs (DOE 1999k). Waste sites in the 300 Area are currently undergoing remediation, consisting of excavating contaminated soils and structural materials. The 300 Area has also been proposed for accelerated remediation of waste sites and inactive buildings to support future non-DOE uses. The 300 Area covers 150 hectares (370 acres). The Radiochemical Processing Laboratory (RPL) (Building 325) and the Development Fabrication Test Laboratory (Building 306–E) are located in this area and would be used under certain alternatives under this NI PEIS.

The 400 Area, 8 kilometers (5 miles) northwest of the 300 Area, is the location of the recently shut down FFTF and FMEF. FFTF was designed and built as a liquid-metal (sodium) cooled reactor to be the nation's leading test reactor for development and testing of materials and equipment for the Liquid Metal Fast Breeder Reactor Programs. The reactor was neither designed nor operated as a breeder reactor itself. FFTF operated for about 10 years (1982–1992) as a national research facility resting advanced nuclear fuels, materials, components, active and passive reactor safety technologies, and gaining operating experience for the next generation of nuclear reactors. FFTF also produced a wide variety of medical isotopes and made tritium for the U.S. fusion research program. In 1995, FFTF was in the process of being shutdown, but was directed in 1997 to maintain a standby condition. The final future is to be determined in the Record of Decision for this NI PEIS.

FMEF, located in the 400 Area adjacent to the west of FFTF, was constructed in the late 1970s and early 1980s to perform fuel fabrication and development and postirradiation examination of breeder reactor fuels. FMEF was never operated and is currently in a lay-up condition suitable for a future mission. The building is clean and uncontaminated, as no nuclear materials were ever introduced into the building. The six-level process building (Building 427) is the main structure of FMEF and encloses about 17,400 square meters (188,000 square feet) of operating area. FMEF also consists of several connected buildings. The exterior walls are reinforced concrete and the cell walls are constructed of high-density concrete. The facility was designed and constructed for spent fuel examination and was equipped for mixed oxide fuel fabrication.

Other areas at Hanford include Energy Northwest facilities and a section of land currently owned by Washington State for the disposal of hazardous substances. Energy Northwest currently operates Washington Nuclear Plant Number 2 on leased land approximately 4 kilometers (2.5 miles) northeast of the 400 Area. Originally leased for the operation of three nuclear power plants, construction of two of the plants was stopped and now other industrial options are being considered. Other facilities at Hanford include a specialized training center, the Hazardous Materials Management and Emergency Response (HAMMER) Volpentest Training and Education Center, which is used to train hazardous materials response personnel. It is located in the southeastern portion of the site and covers about 32 hectares (80 acres). The Hanford Patrol Training Academy, a regional law-enforcement training facility, provides classrooms, library resources, practice shoot houses, an exercise gym, and an obstacle course. The Laser Interferometer Gravitational Wave Observatory (LIGO), a national research facility, built by the National Science Foundation for scientific research, is designed to detect cosmic gravitational waves. The facility consists of two optical tube arms, each 4 kilometers (2.5 miles) long, arrayed in an "L" shape, and extremely sensitive to vibrations (DOE 1999k).

The 700 Area is the administrative center in downtown Richland and consists of Government-owned buildings (e.g., the Federal Building).

In addition, there are DOE-leased facilities and DOE contractor-owned facilities that support Hanford operations. These facilities are on private land south of the 300 Area and outside of the 1100 and 3000 Areas (DOE 1996b:3-21).

DOE has transferred the 1100 Area (which served as a procurement, central warehousing, vehicle maintenance, transportation, and distribution center for the Hanford Site) and the smaller 300 Area to the Port of Benton for use in economic development and diversification (DOE 1998g; DOE 1998h; DOE 1998i).

3.4.1 Land Resources

Land resources include land use and visual resources. Each of these resource areas is described for the site as a whole, as well as for the locations of the proposed activities.

3.4.1.1 Land Use

Land may be characterized by its potential for the location of human activities (land use). Natural resource attributes and other environmental characteristics could make a site more suitable for some land uses than for others. Changes in land use may have both beneficial and adverse effects on other resources such as ecological, cultural, geological, aquatic, and atmospheric.

3.4.1.1.1 General Site Description

The Tri-Cities area southeast of Hanford includes residential, commercial, and industrial land use. This area, encompassing the cities of Richland, Kennewick, and Pasco, is the population center closest to Hanford. Additional cities near the southern boundary of Hanford include Benton City, Prosser, and West Richland. Agriculture is a major land use in the remaining areas surrounding Hanford. In 1996, wheat was the largest crop in terms of area planted in Benton, Franklin, and Grant counties. Alfalfa, apples, asparagus, cherries, corn, grapes, and potatoes are some of the other major crops in Benton, Franklin, and Grant counties.

DOE has designated the entire Hanford Site as a National Environmental Research Park, an outdoor laboratory for ecological research to study the environmental effects of energy development. The Hanford National Environmental Research Park is a shrub-steppe habitat that contains a wide range of semiarid land ecosystems and offers the opportunity to examine linkages between terrestrial, subsurface, and aquatic environments.

Land use designations at Hanford include preservation, conservation, recreation, industrial, and research and development (**Figure 3–6**). Approximately 6 percent of the site has been disturbed and is occupied by DOE facilities (Neitzel 1999). Hanford contains a variety of widely dispersed facilities, including retired reactors, research and development facilities, and various deactivated production and processing plants. Preservation and conservation are the largest land use categories at Hanford. Industrial areas include the 200 Areas, an area to the east of the 200 Areas, and most of the southeast corner of the site.

Important areas within the preservation land use category include the Hanford Reach National Monument, that incorporates a portion of the Columbia River corridor, as well as the Fitzner-Eberhardt Arid Lands Ecology Reserve to the south and west, and portions of the Hanford Site north of the Columbia River (65 FR 37253). Other special status land in the vicinity include McNary National Wildlife Refuge, administered by the U.S. Fish and Wildlife Service, and the Columbia River Islands Area of Critical Environmental Concern and McCoy Canyon, both administered by the Bureau of Land Management.

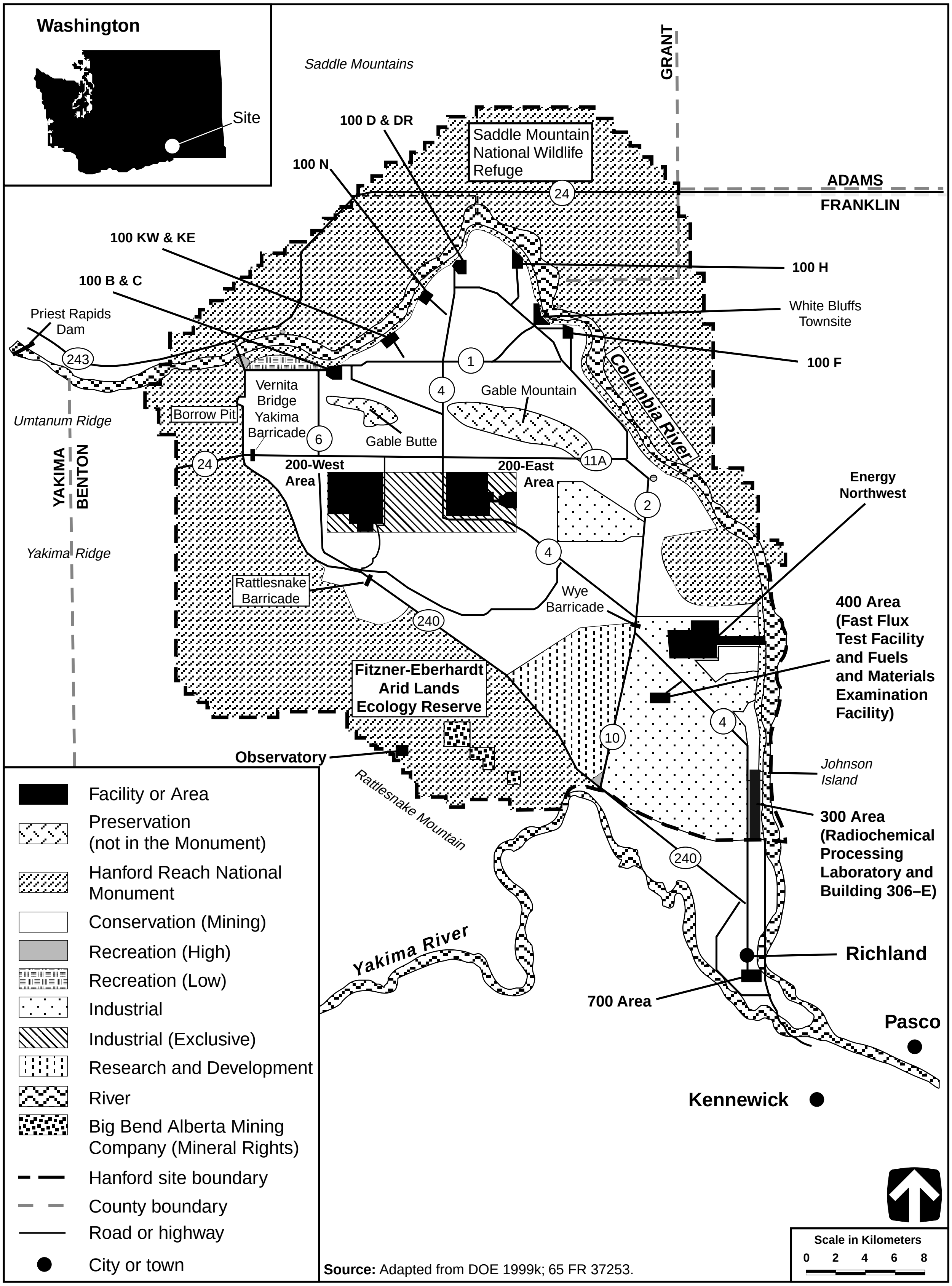

Figure 3–6 Generalized Land Use at the Hanford Site and Vicinity

The Columbia River, which is adjacent to and runs through the Hanford Site, is used for numerous purposes including public boating, water skiing, fishing, hunting, transportation, irrigation, and municipal water supply. Public access is allowed on certain islands, while other areas are considered sensitive because of unique habitats and the presence of cultural resources. The area known as the Hanford Reach includes the quarter-mile strip of public land on either side of the last free-flowing, nontidal segment of the Columbia River. On June 9, 2000, the President issued a proclamation that established the Hanford Reach National Monument (65 FR 37253) covering 78,900 hectares (195,000 acres). This proclamation recognizes the unique character and biological diversity of the area, as well as its geological, paleontological, historic, and archaeological significance. The U.S. Fish and Wildlife Service will manage the monument under existing agreements with DOE. Land within the monument that is not subject to existing agreements will be managed by DOE; however, DOE will consult with the Secretary of the Interior when developing any management plans affecting these lands.

The Hanford Site has developed a comprehensive land use plan to define how to best use the land at the site for the next 50 years (DOE 1999k). The plan provides the framework within which future use of the site's lands and resources will occur. This framework consists of four basic elements including: a land use map depicting land uses for the site; land use definitions describing the purpose, intent, and principal uses of each land use designation; a set of policies directing land use actions; and implementing procedures. Figure 3–6 reflects the land use categories developed in the *Hanford Comprehensive Land-Use Plan EIS* as modified by the designation of the Hanford Reach National Monument.

Under separate treaties signed in 1855, lands occupied by the present Hanford Site were ceded to the United States by the Confederated Tribes and Bands of the Yakama Indian Nation, the Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe of Western Idaho. Under these treaties, the tribes retained the right to fish in their usual and accustomed places, hunt, gather roots and berries, and pasture horses and cattle on open, unclaimed lands. Tribal fishing rights have been recognized as effective within the Hanford Reach. Tribal governments and DOE, however, disagree over the applicability of tribal member's treaty-reserved rights to hunt, gather plants, and pasture livestock on the Hanford Site. The tribes and DOE have proceeded with the land use planning process, while reserving all rights to assert their respective positions regarding treaty rights (DOE 1999k).

3.4.1.1.2 Locations of Proposed Activities

300 AREA

The *Hanford Comprehensive Land-Use Plan EIS* (DOE 1999k) and Record of Decision (64 FR 61615) have designated the 300 Area as an industrial area for the foreseeable future. An industrial area is defined in that EIS as an area that is suitable and desirable for activities such as reactor operations, transport facilities, mining, manufacturing, warehousing, and distribution operations. The 300 Area, which is just north of the city of Richland and west of the Columbia River, covers 150 hectares (371 acres). It is the site of former reactor fuel fabrication facilities and is also the principal location of nuclear research and development facilities serving the Hanford Site. RPL/306–E are in the 300 Area.

400 AREA

Under the *Hanford Comprehensive Land-Use Plan EIS* (DOE 1999k) and Record of Decision (64 FR 61615) land in the 400 Area is designated for industrial use, including reactor operations, for the foreseeable future. Land in the 400 Area is designated for reactor operations. The 400 Area occupies 60 hectares (150 acres) and is 7 kilometers (4.3 miles) to the west of the nearest site boundary. It is the site FFTF and FMEF. FFTF is a test reactor that was used for the development and testing of materials and equipment for the liquid metal breeder reactor program. FMEF is an unused building designed and constructed for spent fuel examination and equipped for mixed oxide fuel fabrication.

3.4.1.2 Visual Resources

Visual resources are natural and human-created features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape.

3.4.1.2.1 General Site Description

Hanford is in the Pasco Basin of the Columbia Plateau north of the city of Richland, where the Yakima and Columbia Rivers join. The topography of land in the vicinity of Hanford ranges from generally flat to gently rolling. Rattlesnake Mountain, rising to 1,060 meters (3,480 feet) above mean sea level, forms the southwestern boundary of the site. Gable Mountain and Gable Butte are the highest land forms within the site, rising approximately 60 meters (200 feet) and 180 meters (590 feet), respectively. The Columbia River flows through the northern part of the site and, turning south, forms part of the eastern site boundary. White Bluffs, steep whitish-brown bluffs adjacent to the Columbia River and above the northern boundary of the river in this region, are a striking feature of the landscape.

Typical of the regional shrub-steppe desert, the site is dominated by widely spaced, low-brush grasslands. A large area of unvegetated, stabilized sand dunes extends along the east boundary, and unvegetated blowouts are scattered throughout the site. Hanford is characterized by mostly undeveloped land, with widely spaced clusters of industrial buildings along the southern and western banks of the Columbia River and at several interior locations.

The adjacent visual landscape consists primarily of rural rangeland and farms. The city of Richland, part of the Tri-Cities area, is the only adjoining urban area. Viewpoints affected by DOE facilities are primarily associated with the public access roadways (including State Routes 24 and 240, Hanford Road, Horn Rapids Road, Route 4 South, and Steven Drive), the bluffs, and the northern edge of the city of Richland. The Energy Northwest (formerly known as the Washington Public Power Supply System) nuclear reactors and DOE facilities are brightly lit at night and are highly visible from many areas. Developed areas are consistent with a Bureau of Land Management Visual Resource Management Class IV rating, while the remainder of the Hanford Site ranges in Visual Resource Management rating from Class II to Class III (DOI 1986). Management activities within Class II and III areas may be seen, but should not dominate the view, while management activities in Class IV areas dominate the view and are the focus of viewer attention.

3.4.1.2.2 Locations of Proposed Activities

300 AREA

The tallest structures within the 300 Area vicinity are the water towers, with a height of 40 meters (130 feet), and the meteorological tower with a height of 61 meters (200 feet) in height. The 300 Area is visible from Route 4, which runs in a north-south direction along the western boundary of the site (Nielsen 2000). Because the 300 Area is a highly developed industrial area, it has a Visual Resource Management Class IV rating. Natural features of visual interest within a 40-kilometer (25-mile) radius include the Columbia River immediately to the east, Rattlesnake Mountain at 24 kilometers (15 miles), Gable Mountain at 27 kilometers (17 miles), and Gable Butte at 35 kilometers (22 miles).

400 AREA

FMEF, the tallest building in the 400 Area, is 30 meters (100 feet) tall and can be seen from State Route 240. Developed areas within the 400 Area are consistent with a Visual Resource Management Class IV rating. Natural features of visual interest within a 40-kilometer (25-mile) radius include the Columbia River at 6.8 kilometers (4.2 miles), Rattlesnake Mountain at 17 kilometers (11 miles), Gable Mountain at 19 kilometers (12 miles), and Gable Butte at 27 kilometers (17 miles).

3.4.2 Noise

Noise is unwanted sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities or diminish the quality of the environment.

3.4.2.1 General Site Description

Major noise sources within the Hanford site include various facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). Wind has been identified as a major source of background sound levels at Hanford. Data from two noise surveys indicate that background noise levels (measured as the 24-hour equivalent sound level) at Hanford range from 30 to 60.5 dBA. The 24-hour background sound level in undeveloped areas at Hanford ranges from 24 to 36 dBA, except when high winds elevate sound levels. The primary source of noise at the site and nearby residences is traffic. Most Hanford industrial facilities are far enough from the site boundary that noise levels at the boundary from these sources are not measurable, or are barely distinguishable from background noise levels. Hanford is currently in compliance with state noise regulations. Noise sources, existing noise levels at Hanford, and noise standards are described in the *Storage and Disposition PEIS* (DOE 1996b:3-29–3-31, F-31, F-32) and in the 1999 *Hanford Site National Environmental Policy Act (NEPA) Characterization* (Neitzel 1999:4.137-138).

The potential impact of traffic noise resulting from activities at Hanford was evaluated for a draft EIS addressing the siting of the proposed New Production Reactor (Neitzel 1999:4.138). Estimates were made of baseline traffic noise along two major access routes: State Route 24, leading from the Hanford Site west to Yakima, and State Route 240, south of the site and west of Richland, where it handles maximum traffic volume. About 9 percent of the employees at Hanford commute by vanpool or bus. Modeled traffic noise levels (equivalent sound level [1-hour]) at 15 meters (50 feet) from State Route 24 for both peak and offpeak periods were 62 dBA. Traffic noise levels from State Route 240 for both peak and offpeak periods were 70 dBA. These traffic noise levels were projections based on employment levels about 30 percent higher than actual levels at Hanford in 1997. Existing traffic noise levels may be different as a result of changes in site employment and ride-sharing activities (DOE 1999e:3-8; Neitzel 1999:4.138-4.141).

Washington State has established noise standards for different source and receiving areas. Hanford belongs to source area Class C (industrial). The maximum allowable noise level for residential, commercial, and industrial areas is 50 to 70 dBA (DOE 1996b:3-29 and 3-31, Neitzel 1999:4.138). The EPA guidelines for environmental noise protection recommend a day-night average sound level of 55 dBA as sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974:29). Land use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that yearly day-night average sound levels less than 65 dBA are compatible with residential land uses (14 CFR Part 150). These guidelines further indicate that noise levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures. It is expected that for most residences near Hanford, the day-night average sound level is less than 65 dBA and is compatible with the residential land use, although for some residences along major roadways noise levels may be higher.

3.4.2.2 Locations of Proposed Activities

300 AREA

No distinguishing noise characteristics in the 300 Area have been identified. The 300 Area is just north of Richland and adjacent to the site boundary along the Columbia River. No sound level data have been collected in this area except for measurements that reflect traffic noise levels.

400 AREA

No distinguishing noise characteristics in the 400 Area have been identified. The 400 Area is far enough away from the site boundary, 7 kilometers (4.3 miles), that noise levels at the site boundary from these sources are not measurable or are barely distinguishable from background levels.

3.4.3 Air Quality

Air pollution refers to the introduction, directly or indirectly of any substance into the air that could endanger human health, harm living resources and ecosystems as well as material property, and impair or interfere with the comfortable enjoyment of life or other legitimate uses of the environment. Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

3.4.3.1 General Site Description

The climate at Hanford and the surrounding region is characterized as that of a semiarid steppe. The humidity is low and winters are mild. The average annual temperature is 11.8 °C (53.3 °F); average monthly temperatures range from a minimum of -0.4 °C (31.3 °F) in January to a maximum of 24.6 °C (76.2 °F) in July. The average annual precipitation is 16 centimeters (6.3 inches). Prevailing winds at the Hanford Meteorological Station are from the west-northwest. The average annual wind speed is 3.4 meters per second (7.6 miles per hour) (Dirkes, Hanf, and Poston 1999:7.5; DOE 1999e:3-5).

Most of Hanford is within the South-Central Washington Intrastate Air Quality Control Region #230, but a small portion of the site is in the Eastern Washington-Northern Idaho Interstate Air Quality Control Region #62. None of the areas within Hanford and its surrounding counties are designated as nonattainment areas, with respect to NAAQS for criteria air pollutants (40 CFR Section 81.348). However, particulate matter concentrations can reach relatively high levels in eastern Washington State because of extreme natural events, such as dust storms, volcanic eruptions, and large brush fires. Washington State ambient air quality standards have not considered "rural fugitive dust" from exceptional natural events when estimating the maximum background concentrations of particulates in the area east of the Cascade Mountain crest. In June 1996, EPA adopted the policy that allows dust storms to be treated as uncontrollable natural events. The air quality impact of dust storms can therefore be excluded during the determination of whether this area is in nonattainment for atmospheric particulates. (Neitzel 1999). Applicable NAAQS and Washington State ambient air quality standards are presented in **Table 3–21**.

The primary sources of air pollutants at Hanford include emissions from power generation, vehicles, construction, environmental remediation, and waste management activities. The existing ambient air pollutant concentrations at the site boundary attributable to sources at Hanford are presented in Table 3–21. These

Table 3–21 Comparison of Modeled Ambient Air Concentrations from Hanford Sources with Most Stringent Applicable Standards or Guidelines

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Hanford Concentration (micrograms per cubic meter)[b]
Criteria pollutants			
Carbon monoxide	8 hours	10,000[c]	0.08
	1 hour	40,000[c]	0.30
Nitrogen dioxide	Annual	100[c]	0.03
Ozone	1 hour	235[d]	(e)
PM_{10}	Annual	50[c]	0.01
	24 hours (interim)	150[c]	0.02
Sulfur dioxide	Annual	50[f]	<0.01
	24 hours	260[f]	<0.01
	3 hours	1,300[c]	0.01
	1 hour	1,000[f]	0.02
	1 hour	660[f, g]	0.02
Other regulated pollutants			
Gaseous fluoride	30 days	0.84[f]	(h)
	7 days	1.7[f]	(h)
	24 hours	2.9[f]	(h)
	12 hours	3.7[f]	(h)
Total suspended particulates	Annual	60[i]	<0.01
	24 hours	150[i]	<0.02

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} (interim) standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.
b. Site contributions based on a 1994 emissions inventory.
c. Federal and state standard.
d. Federal 8-hour standard is currently under litigation.
e. Not directly emitted or monitored by the site.
f. State standard.
g. Not to be exceeded more than twice in any 7 consecutive days.
h. No sources identified at the site.
i. No data are available with which to assess particulate matter concentrations.

Note: NAAQS also include standards for lead. No sources of lead emissions have been identified at the site. Emissions of other air pollutants not listed here have been identified at Hanford, but are not associated with any alternative evaluated. EPA revised the ambient air quality standards for particulate matter and ozone in 1997; however, these standards were under litigation. In 1999, new standards, effective on September 16, 1997, could not be enforced. The ozone standard is a 1-hour concentration of 235 micrograms per cubic meter (0.12 parts per million) (62 FR 38856). The 8-hour standard could not be enforced. For particulate matter, the current PM_{10} annual standard is retained (62 FR 38652).

Source: DOE 1999e; 40 CFR Part 50; WDEC 1998.

concentrations are based on dispersion modeling using emissions for 1994 with the conversion of facility heating and power to natural gas accounted for. The emissions were modeled using meteorological data from 1989–1990. Only those pollutants that would be emitted by any of the alternatives evaluated in this NI PEIS are presented. Because Hanford sources are limited and background concentrations of criteria pollutants are well below ambient standards, Hanford emissions should not result in air pollutant concentrations that violate the ambient air quality standards. As shown in Table 3–21, these modeled concentrations from Hanford sources represent a small percentage of the ambient air quality standards. Detailed information on emissions of other pollutants at Hanford is discussed in the *Hanford Site NEPA Characterization* (Neitzel 1999:4.27–4.32).

There are no Prevention of Significant Deterioration Class I areas within 100 kilometers (62 miles) of Hanford. A Class I area is one in which very little increase in pollution is allowed due to the pristine nature of the area. Hanford and its vicinity are classified as a Class II area in which more moderate increases in pollution are allowed. Hanford operates under a Prevention of Significant Deterioration permit issued in 1980. New emission sources require a Prevention of Significant Deterioration increment consumption analysis. The recent designation of the Hanford Reach as a national monument (65 FR 37253) might lead to a proposal to redesignate this area, that includes part of Hanford and adjoining areas, as Prevention of Significant Deterioration Class I, although that appears unlikely at this time due to a variety of political and technical issues.

A sitewide air operating permit is being developed for Hanford, scheduled to be issued in mid 2000 in accordance with Title V of the Clean Air Act and Amendments of 1990 and the Federal and state programs under 40 CFR 70 and WAC 173-401, respectively. The Hanford air operating permit will include a compilation of requirements for both radioactive emissions now covered by the existing state license and nonradioactive emissions. The primary effects of the air operating permit will be to consolidate approval orders and applicable requirements in to one permit, reuqire the permitted party to conduct periodic monitoring to show continuous compliance with permit conditions and applicable requirements, require biannual reporting and annual certification of continuous compliance, and increase the state's and EPA's enforcement position.

Based on 1996 monitoring conducted off site by the Washington State Department of Ecology, the annual and 24-hour PM_{10} standards were not exceeded (Neitzel 1999:4.29). Ambient air quality at Hanford is discussed in more detail in the *Hanford Site Environmental Report for Calendar Year 1998* (Dirkes, Hanf, and Poston 1999).

Routine monitoring of most nonradiological pollutants is not conducted at the site. Monitoring of nitrogen oxides and total suspended particulates at Hanford has been discontinued as a result of phasing out programs for which the monitoring was required. Carbon monoxide, sulfur dioxide, and nitrogen dioxide have been monitored periodically in communities and commercial areas southeast of Hanford. In 1995, air samples of semivolatile organic compounds were collected on the site and at an offsite location, and the results are discussed in the site's annual environmental report. All concentrations of these compounds were below the applicable risk-based concentrations.

3.4.3.2 Locations of Proposed Activities

300 AREA

Prevailing winds in the 300 Area are from the southwest. The 300 Area emits various nonradiological air pollutants from power generation and process sources (Neitzel 1999:4.30, 4.31).

400 AREA

Prevailing winds in the 400 Area are from the south-southwest, with a secondary maximum from the northwest. The 400 Area currently has no nonradioactive air pollutant emission sources of concern (Neitzel 1999:4.30).

3.4.4 Water Resources

Water resources include all forms of surface water and subsurface groundwater.

3.4.4.1 Surface Water

Surface water includes marine or freshwater bodies that occur above the ground surface, including rivers, streams, lakes, ponds, rainwater catchments, embayments, and oceans.

3.4.4.1.1 General Site Description

Major surface water features at Hanford include the Columbia River, Columbia riverbank seepage, springs, and ponds. In addition, the Yakima River flows along a short section of the southern boundary of the site. The Columbia River is the second largest river in the contiguous United States in terms of total flow and is the dominant surface water feature on the site. Flow of the Columbia River is regulated by several dams, seven upstream and four downstream from the site. The nearest dam upstream from Hanford is the Priest Rapids Dam, and the closest downstream dam is the McNary Dam. The Hanford Reach is the portion of the Columbia River that extends from Priest Rapids Dam to the upstream edge of Lake Wallula behind McNary Dam. Because the flows are regulated, flow rates in the Hanford Reach can vary considerably; it is the last remaining free-flowing, nontidal section of the river. The average daily flow rate at Priest Rapids Dam is 3,360 cubic meters (118,700 cubic feet) per second. Peak flows generally occur from April through June corresponding to runoff from snowmelt. Due to larger than normal snowpacks, the peak flow rate in 1997 was nearly 11,750 cubic meters (415,000 cubic feet) per second. The width of the river varies from approximately 300 to 1,000 meters (1,000 to 3,300 feet) within the Hanford Site (Neitzel 1999:4.55, 4.56).

Primary uses of the Columbia River include hydroelectric power generation, irrigation of crops in the Columbia Basin, and barge transportation. The Hanford Reach is the upstream navigable limit of barge traffic. The Columbia River is also used extensively for recreation, including fishing, hunting, boating, sailboarding, water-skiing, diving, and swimming. In addition to a water supply source for the Hanford Site, several communities use the Columbia River as their source of drinking water (Neitzel 1999:4.56). Nine of the 12 DOE-owned, contractor-operated water plants on the Hanford Site use water from the Columbia River (Dirkes, Hanf, and Poston 1999:4.47–4.49).

The Washington State Department of Ecology classifies the Columbia River, from Grand Coulee to the Washington-Oregon border and encompassing the Hanford Reach, as Class A (excellent). Class A waters are suitable for essentially all uses, including raw drinking water, recreation, and wildlife habitat. Federal and state drinking water standards, and DOE Order 5400.5 (DOE 1993), apply to the Columbia River and are currently being met (DOE 1999k:4-35). Although no federally designated Wild and Scenic Rivers exist in the Hanford Site vicinity, the Hanford Reach is being considered for listing under the National Wild and Scenic Rivers Act as part of broader resource conservation initiatives (DOE 1999k:4-5; Neitzel 1999:6.10).

DOE continues to assert a federally reserved water withdrawal right for the Columbia River. Hanford withdraws approximately 13.5 billion liters (3.6 billion gallons) per year from the Columbia River (DOE 1999e:3-30).

About one-third of the Hanford Site drains into the Yakima River. The average daily flow rate for the Yakima River is 104 cubic meters per second (3,670 cubic feet per second). The peak average daily flow rate in 1997 was nearly 1,300 cubic meters per second (45,900 cubic feet per second) (Neitzel 1999:4.58).

Rattlesnake Springs and Snively Springs are in the western portion of the site and flow into intermittent streams that infiltrate rapidly into the surface sediments. Water discharged from Rattlesnake Springs flows down Dry Creek, a tributary to Cold Creek, for about 3 kilometers (1.9 miles) before infiltrating into the ground. An alkaline spring has also been documented at the east end of Umtanum Ridge. Several springs are also found on the slopes of Rattlesnake Mountain along the western and southwestern edges of the site (DOE 1999k:4-30; Neitzel 1999:4.58). The seepage of groundwater into the Columbia River was documented along the Hanford Reach long before Hanford Site operations began. This seepage occurs both below the river surface and on the exposed riverbank. These relatively small seeps flow intermittently, influenced primarily by changes in river level. Hanford-origin contaminants have been documented in these discharges along the Hanford Reach (DOE 1999k:4-30; Neitzel 1999:4.65).

Other naturally occurring surface water features include West Lake and three previously undocumented clusters of approximately 20 vernal ponds or pools. The clusters are located on the eastern end of Umtanum Ridge, in the central part of Gable Butte, and at the eastern end of Gable Mountain. The ponds appear to form during the relatively wetter winter ponds in shallow depressions underlain by a layer of basalt (DOE 1999k:4-31; Neitzel 1999:4.67).

Artificial ponds also exist on the site primarily associated with waste management activities. These include: water storage ponds in the 100 K-Area, the two Treated Effluent Disposal Facility (TEDF) disposal ponds and the three Liquid Effluent Retention Facility (LERF) impoundments adjacent to the 200-East Area, and the 400 Area Pond (or FFTF Pond) used by FFTF and other facilities West Lake is another water body located north of the 200 Areas (DOE 1999k:4-31; Neitzel 1999:4.57, 4.67). While West Lake, a natural pond that predates Hanford operations, has not received effluents, it was sustained by the artificially elevated water table beneath much of Hanford, attributable to historic waste management activities and current wastewater disposal in the 200 Areas. Although not accessible to the public, these ponds are accessible by waterfowl (DOE 1999k:4-32; Neitzel 1999:4.67, 4.88). In addition to these manmade features, there are irrigation ponds and wetlands located in the northwest portion of the site and north of the Columbia River (Neitzel 1999:4.57, 4.67).

In 1998, the Hanford Site had two NPDES permits: Permit #WA-000374-3 and Permit #WA-002591-7. Permit #WA-000374-3 included four inactive outfalls in the 100-N Area and three active outfalls (two in the 100-K Area and one in the 300 Area). There were two instances of noncompliance for these outfalls in 1998. Permit #WA-002591-7 covered one outfall located at the 300 Area Treated Effluent Disposal Facility. The 300 Area Treated Effluent Disposal Facility had 14 exceedances in 1998. This disposal facility was in normal operation and meeting design specifications at the time of these events. All indications suggest that the facility is unable to consistently meet the restrictions of the facility's NPDES permit, despite the use of the best available technology. An application for a permit modification was submitted to EPA in November 1997 (Dirkes, Hanf, and Poston 1999:2.24, 2.25). The modification requested transfer of the two active 100-K Area outfalls from Permit #WA-000374-3 to Permit #WA-002591-7, among other items. A revised permit was issued April 2, 1999, and became effective May 5, 1999 (Chapin 1999). Revised effluent limits for the 300 Area Treated Effluent Disposal Facility were established under the modified Permit #WA-002591-7 (Dirkes, Hanf, and Poston 1999:2.25). Permit #WA-000374-3 has elapsed.

Hanford was covered by two industrial stormwater permits (WAR-00-000F, WAR-10-000F) in 1998. An annual comprehensive site compliance evaluation was performed and documented in 1998. In accordance with the September 30, 1998, Federal Register (63 FR 52430), the stormwater general permit for industrial activity (WAR-00-000F) was terminated and replaced by the multisector general stormwater permit (WAR-10-000F). On December 28, 1998, a Notice of Intent was submitted to EPA for coverage under the NPDES multisector permit (WAR-10-000F) (Dirkes, Hanf, and Poston 1999:2.25).

DOE Richland Operations Office has a pretreatment permit (CR-IU005) from the city of Richland for the discharge of wastewater from the Environmental Molecular Sciences Laboratory in the 300 Area. Also, there are numerous sanitary waste discharges to the ground through sanitary systems permitted by the Washington State Department of Health, as well as 400 Area sanitary waste discharges to the Energy Northwest treatment facility. Sanitary waste from the 300 Area and other facilities north of and in Richland discharge to the city of Richland treatment facility (Dirkes, Hanf, and Poston 1999:2.25).

Hanford is subject to a Washington State Department of Ecology liquid effluent consent order that regulates liquid effluent discharges to the ground. All state waste discharge permit applications for discharges covered under the consent order have been submitted. One new state waste discharge permit was issued on May 1, 1998, by the Washington State Department of Ecology (Permit ST-4509 for Hanford cooling water and condensate discharges). In 1998, there were eight noncompliances in three of the seven state waste discharge permits currently in place at the Hanford Site (Dirkes, Hanf, and Poston 1999:2.25, 2.26).

All radiological contaminant concentrations measured in the Columbia River in 1998 were lower than the DOE-derived concentration guides and Washington State ambient surface water quality criteria. For nonradiological parameters, applicable standards for Class A–designated surface water were met, with results comparable to those over the past 5 years. During 1998, there was no evidence of deterioration in water quality attributable to Hanford operations along the Hanford Reach (Dirkes, Hanf, and Poston 1999:4.22, 4.27–4.29).

The Columbia River is also the primary discharge area for the unconfined aquifer underlying Hanford. The site conducts sampling of these groundwater seeps during low flow and refers to them as riverbank springs. Water samples were collected from eight Columbia River shoreline spring areas in 1998. All samples were analyzed for gamma-emitting radionuclides, gross alpha, gross beta, and tritium. Samples from selected springs were analyzed for strontium-90; technetium-99; iodine-129; and uranium-234, 235, and 238. Samples were also analyzed for metals and anions (Dirkes, Hanf, and Poston 1999:4.20, 4.34–4.36).

All radiological contaminant concentrations measured in 1998 were less than the DOE Derived Concentration Guides. Tritium in riverbank springs water at the Old Hanford Townsite and the 100-N Area exceeded the state ambient surface water quality criterion (20,000 picocuries per liter), with the maximum of 120,000 picocuries per liter observed at the Old Hanford Townsite. Gross beta activities in riverbank springs water at the 100-H Area exceeded the ambient criterion (50 picocuries per liter), with a maximum observed value of 72 picocuries per liter. While there are no ambient surface water quality criteria directly applicable to uranium, total uranium levels exceeded the site-specific proposed EPA drinking water standard in the 300 Area (equivalent to 13.4 picocuries per liter), with a maximum total uranium activity of 58 picocuries per liter. Gross alpha activity exceeded the ambient surface water quality criterion of 15 picocuries per liter in riverbank springs water at the 300 Area, with a maximum observed value of 56 picocuries per liter. This is consistent with the elevated uranium levels. All other radionuclide activities in 300 Area springs water were less than ambient surface water quality criteria (Dirkes, Hanf, and Poston 1999:4.36, A.10, A.11, C.3). Elevated uranium activities exist in the unconfined aquifer beneath the 300 Area in the vicinity of uranium fuel fabrication facilities and inactive waste sites. Elevated tritium activities have also been measured in the 300 Area riverbank springs and are indicators of the contaminated groundwater plume emanating from the 200 Areas. However, in 1998, the maximum observed activity level was 9,600 picocuries per liter and below the ambient surface water quality criterion (Dirkes, Hanf, and Poston 1999:4.38, C.4).

Nonradiological contaminants measured in riverbank springs located on the Hanford shoreline in 1998 were below the applicable Washington State ambient surface water acute toxicity level (16 micorgrams per liter), except for chromium concentrations in 100-B, 100-K, 100-D, and 100-H Area springs (Dirkes, Hanf, and Poston 1999:4.38, C.4).

Flooding of the site has occurred along the Columbia River, but chances of recurrence have been greatly reduced by the construction of dams to regulate river flow. Major floods are typically due to the melting of the winter snowpack combined with above normal precipitation (Neitzel 1999:4.60). No maps of flood-prone areas have been produced by the Federal Emergency Management Agency. The Federal Emergency Management Agency produces these maps for areas capable of being developed, and the Hanford Site is not designated for commercial or residential development (DOE 1999k:4-34). However, analyses have been completed to determine the potential for the probable maximum flood. This is determined through hydrologic factors, including the amount of precipitation within the drainage basin, snow melt, and tributary conditions. The probable maximum flood for the Columbia River below the Priest Rapids Dam has been calculated at 40,000 cubic meters (1.4 million cubic feet) per second, which is greater than the 500-year flood (DOE 1999k:4-34; Neitzel 1999:4.60). The extent of the 1948 flood, and the extent of the probable maximum flood, are shown in **Figure 3–7**. Potential flooding due to dam failure has been evaluated by the U.S. Army Corps of Engineers. Upstream failures could have any number of causes, the magnitude of the resultant flooding depending on the size of the breach in the dam. The U.S. Army Corps of Engineers evaluated various scenarios for failure of the Grand Coulee Dam, located approximately 130 kilometers (80 miles) from Hanford, and assumed flow conditions of about 11,300 cubic meters (400,000 cubic feet) per second. The worst-case scenario assumed a 50 percent breach in the dam (**Figure 3–8**). The flood wave from an instantaneous 50 percent breach was calculated to be 600,000 cubic meters (21 million cubic feet) per second. In addition to the areas affected by the probable maximum flood, the remainder of the 100 Area, the 300 Area, and nearly all of Richland, Washington, would be flooded. Determinations were not made for larger instantaneous breaches in the Grand Coulee Dam, because the 50 percent scenario was believed to be the largest conceivable flow from a natural or manmade breach. It was not considered credible that a structure as large as the Grand Coulee Dam could be 100 percent destroyed instantaneously. The analysis also assumed that the 50 percent breach would occur only as the result of direct explosive detonation, and not because of some natural event such as an earthquake (DOE 1999k:4.34; Neitzel 1999:4.60, 4.65).

3.4.4.1.2 Locations of Proposed Activities

300 AREA

Water for the 300 Area, including for RPL/306–E, is provided by the city of Richland, which obtains about two-thirds of its water from the Columbia River (DOE 1999l:3; Neitzel 1999:4.133). Water consumption in the 300 Area is approximately 594 million liters (157 million gallons) per year (DOE 1999l:3). Sanitary wastewater from the 300 Area is discharged to the city of Richland treatment facility (Dirkes, Hanf, and Poston 1999:2.25).

RPL is connected to the 300 Area sanitary sewer system and to a separate retention process sewer system. This system collects equipment cooling water, laboratory waste liquids, and other liquids which have a slight potential for radioactive contamination. The retention process sewer system routes process wastewater to the 307 basins at the 340 Complex and ultimately to the 300 Area Treated Effluent Disposal Facility (TEDF), which operated under NPDES Permit WA002591-7. The system is monitored for radioactivity and, if an alarm is triggered, the effluent is diverted to a dedicated basin at the 340 Complex. Otherwise, the effluent is screened at the 307 basins before being conveyed to the 300 Area TEDF. Direct sampling and analysis of the system is also conducted as needed (DOE 1997c: 4-58, 2000c: C-2, C-3). Historically, RPL has generated an average of 1.13 million liters (300,000 gallons) of sanitary wastewater annually and 2.27 million liters (600,000 gallons) of process wastewater per year (DOE 1997c: 4-58). RPL currently generates 3.6 million liters (950,000 gallons) per year of process wastewater (DOE 2000c:C-3). Liquid, low-level radioactive waste generation has averaged less than 3,800 liters (1,000 gallons) per year (DOE 1997c:4-58, 4-59). Building 306–E is also served by the sanitary sewer and process sewer systems. However, water usage and associated sanitary wastewater generation is low compared to other 300 Area

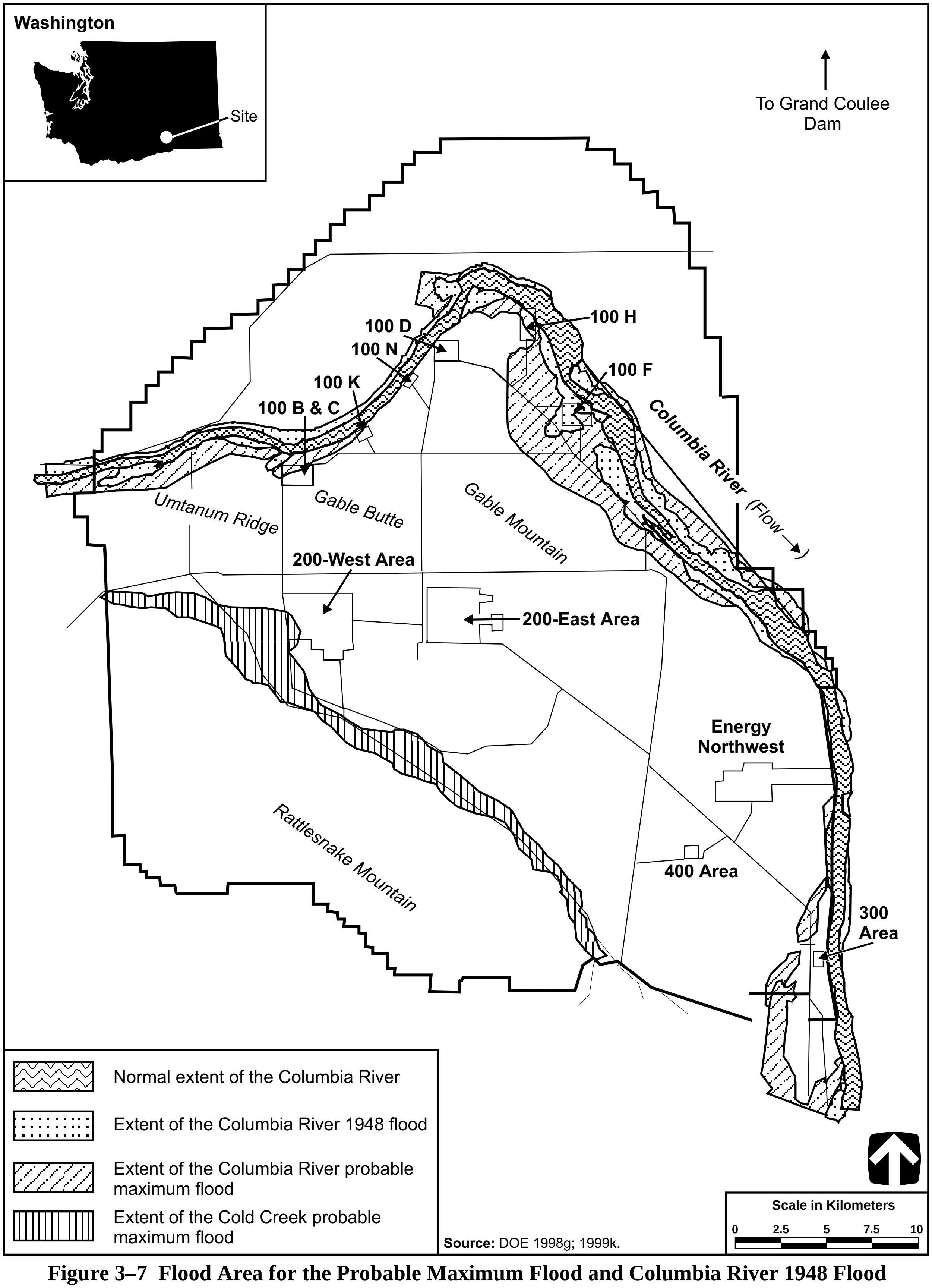

Figure 3–7 Flood Area for the Probable Maximum Flood and Columbia River 1948 Flood

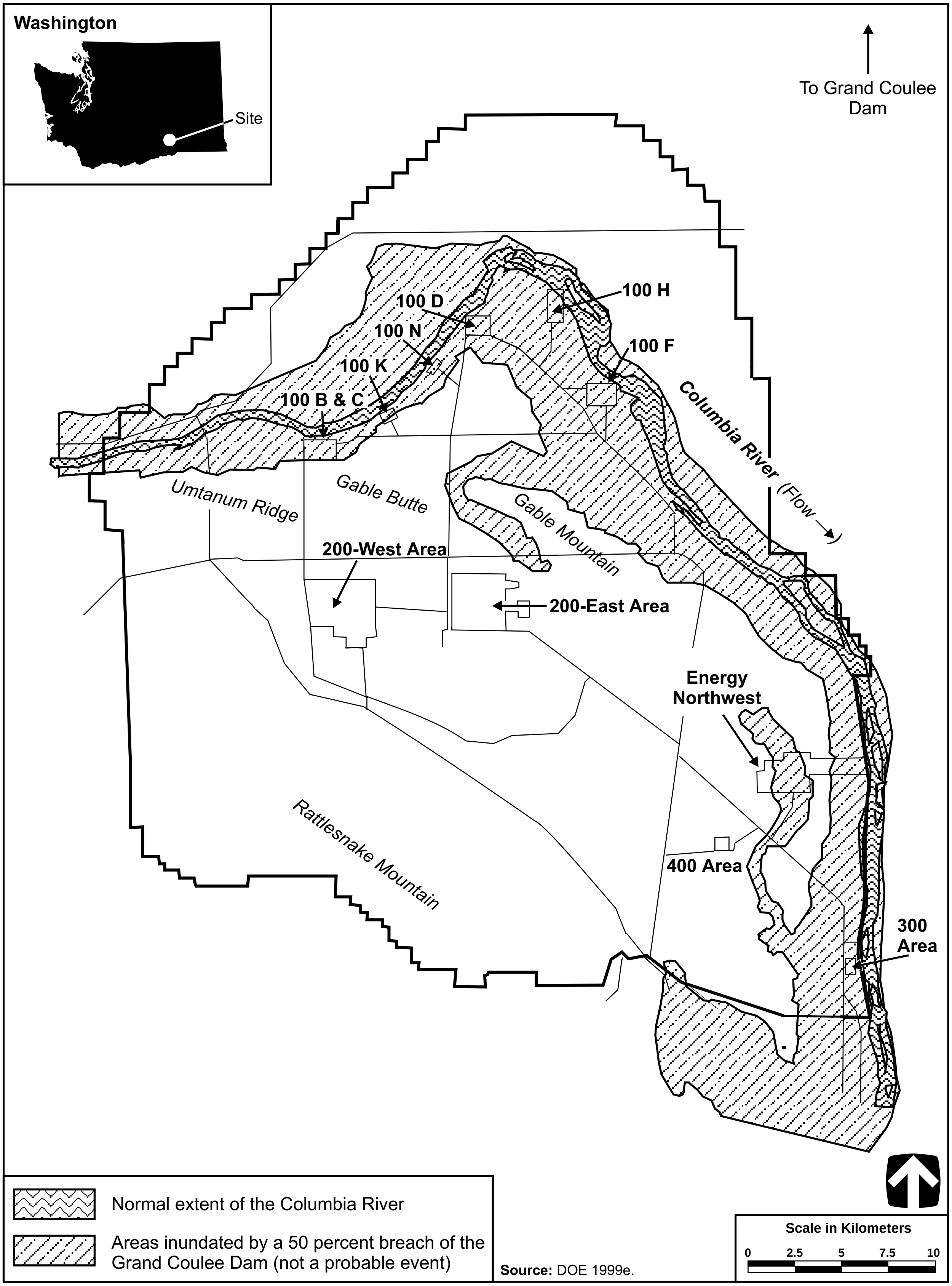

Figure 3–8 Flood Area of a 50 Percent Breach of the Grand Coulee Dam

facilities and not separately metered. Process wastewater with the potential for radioactive contamination is not routinely generated at the facility (DOE 1997c:4-60, B.2-2). The 300 Area is located in the southeast corner of the site adjacent to the Columbia River. Although no site-specific flood analysis is available for the 300 Area, analyses have been completed for the site as a whole, as previously discussed. The 300 Area does not lie within the area postulated to be affected by the probable maximum flood, but locations just to the west of the area would be affected (Figure 3–7). However, the 300 Area would be inundated from a 50 percent breach of the Grand Coulee Dam (Figure 3–8).

400 AREA

The 400 Area is located 6.3 kilometers (3.9 miles) from the west bank of the Columbia River. No specific flooding analyses have been completed for the 400 Area, but analyses have been completed for the site as a whole. According to the sitewide data, the elevation of the ground surface in the 400 Area is about 30 meters (100 feet) above that of the maximum calculated flood from a 50 percent breach of the Grand Coulee Dam (Mecca 1997a:4) (Figure 3–8). Also, the 400 Area is above the elevation of the maximum historical floods of 1894 (Neitzel 1999:4.61) and 1948 (Figure 3–7).

The only surface water body in the vicinity of the 400 Area is the 400 Area Pond (i.e., FFTF Pond or 4608 B/C ponds) located just north of the 400 Area (DOE 1999k:4-31; Neitzel 1999:4.67). It is designed and used to dispose of nonradioactive process wastewater collected by the process sewer system from four 400 Area facilities including FFTF, FMEF, the Maintenance and Storage Facility, and the water pumphouse. The 400 Area Pond consists of two cells 15 by 30 meters (50 by 100 feet) with 1.2-meter (4-foot) walls. The majority of the wastewater discharged to the pond system is cooling tower blowdown from FFTF's eight auxiliary cooling towers and FMEF's currently inactive three cooling towers. Individual effluent streams are collected at a central drain line that runs to the ponds, with the effluent monitored before discharge. Wastewater rapidly percolates into the ground, leaving the ponds dry under normal conditions. The discharges are regulated under State Waste Discharge Permit No. ST-4501. Approximately 76 million liters (20 million gallons) per year of process wastewater is discharged to the ponds. Also, about 3.8 million liters (1.0 million gallons) per year of sanitary wastewater is discharged from 400 Area facilities to the Energy Northwest system for treatment (DOE 2000c:11; Nielsen 1999:38, 39, 41). There are no radiological liquid effluent pathways to the environment from either FFTF or FMEF (DOE 1997c:4-6, 4-29). Liquid, low-level radioactive waste from equipment washing is generated during standby operations at a maximum rate of about 3,800 liters (1,000 gallons) per year. It is collected in tanks and transported to the 200 Area Effluent Treatment Facility for treatment and disposal (DOE 1997c:4-54; Nielsen 1999:39).

FMEF is also equipped with a separate retention/radioactive liquid waste system for handling wastewater not conveyed to the sanitary system due to the slight potential for radioactive contamination of some wastewater streams. Wastewater first flows to two 22,700-liter (6,000-gallon) collection tanks, where the wastewater can be sampled and either discharged by operator command to the process sewer system or, if contaminated, can be trucked to the 200 Area Effluent Treatment Facility, or other suitable facility, for processing (DOE 1997c:B.1-11; DOE 2000c:7).

3.4.4.2 Groundwater

Aquifers are classified by Federal and state authorities according to use and quality. The Federal classifications include Classes I, II, and III groundwater. Class I groundwater is either the sole source of drinking water or is ecologically vital. Classes IIA and IIB are current or potential sources of drinking water (or other beneficial use), respectively. Class III is not considered a potential source of drinking water and is of limited beneficial use.

3.4.4.2.1 General Site Description

Groundwater under Hanford occurs in confined and unconfined aquifer systems. The unconfined aquifer system, referred to as the suprabasalt aquifer system, lies within the glacioalluvial sands and gravels of the Hanford Formation and, to a greater degree, the fluvial and lacustrine sediments of the Ringold Formation. Groundwater generally flows eastward across the site from recharge areas in the higher elevations on the western site boundary, with discharge primarily to the Columbia River (DOE 1999e:3-31; Neitzel 1999:4.68). The Yakima River is also considered a source of recharge (Neitzel 1999:4.68). Because of site wastewater disposal practices, however, the water table has risen as much as 27 meters (89 feet) in the 200 West Area. This has caused groundwater mounding with radial and northward flow components in the 200 Area, although groundwater elevations have declined since 1984 due to decreased wastewater disposal (DOE 1999e:3-31; Neitzel 1999:4.70). Depth to groundwater across the site ranges from 0.3 meters (1 foot) along the Columbia River to more than 106 meters (348 feet) near the center of the site (Barghusen and Feit 1995:2.2-22). Daily river level fluctuations may result in water table fluctuations of up to 3 meters (10 feet) near the Columbia River (Neitzel 1999:4.68).

The confined aquifer system at Hanford consists of sedimentary interbeds and interflow zones that occur between basalt flows in the Columbia River Basalt Group. Aquifer thickness varies from several centimeters to at least 52 meters (171 feet). Recharge of the confined aquifer occurs where the basalt formations are near ground level, and thus surface water is allowed to infiltrate them. Groundwater in the confined aquifer system discharges to the Columbia River, but in some places, moves toward areas of vertical interconnection with the overlying unconfined aquifer system. One such area is near the Gable Mountain anticline (DOE 1999e:3-32; Neitzel 1999:4-68).

Water use in the Pasco Basin, which includes Hanford, is primarily via surface water diversion; groundwater accounts for less than 10 percent of water use (DOE 1999k:4-49). While most of the water used by Hanford is surface water withdrawn from the Columbia River, some groundwater is used. One of the principal users of groundwater was FFTF, which used about 697,000 liters (184,000 gallons) per day when it operated. In addition to the 400 Area, other facilities that use groundwater are the Yakima Barricade and the Patrol Training Academy (Barghusen and Feit 1995:2.2-22). DOE currently asserts an unlimited federally reserved groundwater withdrawal right with respect to existing Hanford operations, and withdraws about 195 million liters (52 million gallons) per year (DOE 1999e:3-32).

Groundwater quality beneath large portions of the Hanford Site has been affected by past liquid waste discharges, primarily to ditches, trenches, and ponds and from spills, injection wells, and leaks from waste storage tanks (Neitzel 1999:4.72). The unconfined aquifer system contains radiological and nonradiological contaminants at levels exceeding water quality criteria and standards. Tritium and iodine-129 are the most widespread radiological contaminants in the unconfined aquifer system, with tritium exceeding the drinking water standard in the 100, 200, 400, and 600 Areas in 1998. Tritium levels are expected to decrease over time because of dispersion and radioactive decay. Nitrate, chromium, and carbon tetrachloride are the most widely distributed nonradiological contaminants (Dirkes, Hanf, and Poston 1999:6.27, 6.49). Detailed information on groundwater monitoring and chemical analysis is presented in the annual site environmental report (Dirkes, Hanf, and Poston 1999). Contamination in the confined aquifer system is typically limited to areas of exchange with the unconfined aquifer system (Dirkes, Hanf, and Poston 1999:6.65). No aquifers have been designated sole-source aquifers (Barghusen and Feit 1995:2.2-22).

3.4.4.2.2 Locations of Proposed Activities

300 AREA

Groundwater flow direction and the water table in the unconfined aquifer system beneath the 300 Area are greatly affected by fluctuations in the level of the Columbia River. During low to average river level conditions, groundwater in the unconfined aquifer system converges beneath the 300 Area from the northwest and southwest and flows in a west to east or northwest to southeast direction, with discharge to the river. High river flows cause the water table to rise above the Hanford-Ringold formation contact and groundwater temporarily flows in a generally southwest to south direction. The unconfined aquifer system consists mainly of Hanford formation gravels and sands, and Ringold Formation gravels and sands with varying amounts of silt and clay. The water table lies within the Hanford formation in most of the 300 Area. The depth to the water table beneath the 300 Area ranges from less than 1 meter (3 feet) near the Columbia River to 18 meters (59 feet) further inland (Hartman 2000:4.27-4.28).

Groundwater quality in the 300 Area has primarily been affected by the uranium fuel fabrication facility and related cooling and sanitary wastewater discharges to the former 316-1 and 316-2 process ponds and subsequently to the 316-5 process trenches (Hartman 2000:4.28, 4.29). Uranium is the major contaminant of concern in the 300 Area with a plume in the unconfined aquifer system extending from the northeast and north-central portions of the 300 Area and south and east across the area to the Columbia River. In fiscal year 1999, uranium was detected at levels above the proposed drinking water maximum contaminant level 20 micrograms per liter over much of the northeastern and eastern parts of the 300 Area, with a high of 322 micrograms per liter detected in one well (Hartman, Morasch, and Webber 2000:2.256, 2.260; Dirkes, Hanf, and Poston 1999:6.42, 6.43). Other groundwater contaminants detected at levels above their maximum contaminant levels (5 and 70 micrograms per liter, respectively) in the deeper part of the unconfined aquifer system in the 300 Area during 1999 include trichloroethylene and cis-1,2-dichloroethylene in one well, with concentrations of 6 and 180 micrograms per liter, respectively. Tetrachloroethylene was detected above the maximum contaminant level (5 micrograms per liter) in one well in the upper part of the unconfined aquifer east and southeast of the 316-5 process trenches at a concentration of 7 micrograms per liter. Nitrate was above the maximum contaminant level (45 milligrams per liter) in two wells in the southern and southwestern portions of the 300 Area, with a concentration of 110 milligrams per liter. This contaminant has been attributed to offsite industry and agriculture. The southward migrating tritium plume originating in the 200-East Area has also impacted the unconfined aquifer in the 300 Area, but with levels below the interim drinking water standard of 20,000 picocuries per liter (Hartman, Morasch, and Webber 2000:2.255, 2.257, 2.258, 2.265, 2.267, A-18).

400 AREA

Groundwater flow across the 400 Area is generally from west to east. The Hanford formation immediately underlying the area consists mainly of the sand-dominated sediments. The water table is located near the contact between the Hanford and Ringold Formations, with the depth to the water table in the 400 Area ranging from about 45 to 50 meters (147 to 164 feet). Hanford formation sediments dominate groundwater flow in the 400 Area because of their relatively high permeability, compared to that of the Ringold Formation sediments. The Ringold Formation consists of gravelly sands, sandy gravel, silty sands and fluvial gravels and overbank and lacustrine silt and clay. The saturated thickness of this aquifer system is about 140 meters (460 feet) (Hartman 2000:4.25).

The 400 Area receives its water from three supply wells, each with a pumping capacity of 833 liters (220 gallons) per minute (DOE 1999l:3-4). One well (499-S1-8J) serves as the primary supply well for all 400 Area needs, including for potable, process, and fire protection uses. The second and third wells (499-S0-8 and 499-S0-7) provide backup and emergency supply, respectively. Chlorination is the only water treatment provided to these wells (DOE 1999l:4; Dirkes, Hanf, and Poston 1999:4.48, 4.49). All of the wells are completed in the unconfined (Hanford/Ringold) aquifer system. The primary production well was installed in 1985 in the lower unconfined aquifer system after tritium contamination was detected in the original two wells, completed near the top of the aquifer (Hartman 2000:4.25). Water usage in the 400 Area ranges from about 284 to 681 liters (75 to 180 gallons) per minute on a seasonal basis. Water is stored in three aboveground storage tanks with a total capacity of about 3 million liters (800,000 gallons) (DOE 1999l:4). Average annual groundwater use in the 400 Area is currently about 197 million liters (52 million gallons) (Nielsen 1999:41).

Nitrate is the only significant contaminant attributable to 400 Area operations. Elevated nitrate concentrations in excess of the drinking water maximum contaminant level have been attributed to the former sanitary sewage lagoon located west and upgradient of the 400 Area process ponds. The maximum concentration in fiscal year 1999 was 92 milligrams per liter; the maximum contaminant level is 45 milligrams per liter. As disposal to the lagoon has been discontinued and the lagoon backfilled, nitrate contamination from this source should diminish with time. Elevated levels of tritium in 400 Area wells continued in 1999 and are associated with the groundwater plume from the vicinity of the Plutonium Uranium Extraction (PUREX) Plant in the 200-East Area. Tritium was found at levels at or above the interim drinking water standard (20,000 picocuries per liter) in samples from the backup supply wells (wells 499-S0-7 and 499-S0-8). The maximum in the backup water supply in fiscal year 1999 was 68,400 picocuries per liter (Hartman, Morasch, and Webber 2000:2.8, 2.235, 2.236). All samples collected from the primary supply well (499-S1-8J) were below the drinking water standard for tritium. Tritium activities were also below the drinking water standard, and the 4-millirem-per-year dose equivalent in the drinking water supply (sampled at the tap), for all sampling events in fiscal year 1998. Nitrate levels also remained below the maximum contaminant level in fiscal year 1999 for the water-supply wells. Fiscal year 1999 and past data from 400 Area and surrounding wells indicates no other constituents are present at levels above drinking water maximum contaminant levels (Hartman et al. 2000:2.236).

3.4.5 Geology and Soils

Geologic resources are consolidated or unconsolidated earth materials, including ore and aggregate materials, fossil fuels, and significant landforms. Soil resources are the loose surface materials of the earth in which plants grow, usually consisting of disintegrated rock, organic matter, and soluble salts.

3.4.5.1 General Site Description

Hanford lies within the Pasco Basin of the Columbia Plateau that is encompassed by the Columbia Intermontane physiographic province (Barghusen and Feit 1995:2.2-12). The rocks beneath Hanford consist of Miocene-age and younger rocks that overlay older Cenozoic sedimentary and volcanic basement rocks. The major geologic units underlying Hanford are, in ascending order: subbasalt (basement) rocks, the Columbia River Basalt Group, and the Ringold Formation, the Plio-Pleistocene unit, early “Palouse” soil, and the Hanford Formation, collectively known as the Suprabasalt Sediments.

The Columbia River Basalt Group consists of sequences of continental flood basalts of Miocene age that cover an extensive area across Washington, Oregon, and Idaho. Volcaniclastic (volcanic-sedimentary) and fluvial (stream deposited) sedimentary materials of the Ellensburg Formation are interbedded within the group. Airfall tuff (consolidated volcanic ash) is the dominant volcaniclastic material at the Hanford Site. The Ringold Formation is exposed in the White Bluffs east of the Columbia River on the site and consists of sedimentary deposits dominated by fluvial gravel and sand deposits along with lake-deposited sand, silt, and clay. The Plio-Pleistocene unit is locally derived, consisting of alluvium, colluvium, and/or calcium-cemented soil material (caliche). Wind-deposited sand and silt characterizes the early "Palouse" soil. Gravel, sand, and silt deposits, comprising the unit informally designated as the Hanford formation, are the products of cataclysmic floods that inundated the Pasco Basin and the Hanford Site during the Pleistocene. Younger surficial materials also include alluvium deposited by streams and rivers, as well as active sand dune fields (i.e., north of Energy Northwest) (DOE 1999k:4.12–4-22; Neitzel 1999:4.35–4.44).

Basalt outcrops are exposed on ridges at Gable Mountain, Gable Butte, and the Saddle Mountains in the northern part of Hanford, and on Rattlesnake Hills and Yakima Ridge, overlapping the western and southwestern edges of the site. Other than crushed rock, sand, and gravel, no economically viable geologic resources have been identified at Hanford (DOE 1999e:3-24).

Known faults in the Hanford area include those on Gable Mountain and the Rattlesnake-Wallula alignment. The faults in Central Gable Mountain are considered capable, although there is no observed seismicity on or near Gable Mountain. The Rattlesnake-Wallula alignment is interpreted as possibly being capable because there appear to be active portions of the fault system 56 kilometers (35 miles) southwest of the central part of Hanford (Barghusen and Feit 1995:2.2-13, 2.2-14). A capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years, or recurrent movement within the past 500,000 years (10 CFR Part 100, Appendix A).

Seismicity of the Columbia Plateau, as determined by the rate of earthquakes per area and the historical magnitude of these events, is lower than that of other regions in the Pacific Northwest. The two largest earthquakes near Hanford occurred in 1918 and 1973; each had an approximate Richter magnitude of 4.4 and a Modified Mercalli Intensity of V (Table 3–3). They occurred in the central portion of the Columbia Plateau north of Hanford. Based on the most recent seismic analyses, an earthquake with a maximum horizontal acceleration of 0.2 g is calculated to have an annual probability of occurrence of 1 in 2,500 at Hanford (Neitzel 1999:4.52, 4.55). While evidence has been mounting since at least the early 1990s that great earthquakes, with a magnitude of 8 to 9, have occurred in the past in association with the Cascadia Subduction Zone off the coast of the Pacific Northwest, the increased risk is primarily to Western Washington (USGS 1995).

As discussed in more detail in Section 3.2.5.1, USGS has developed new seismic hazard maps as part of the National Seismic Hazard Mapping Project that are based on response spectral acceleration. These maps have been adapted for use in the new *International Building Code* (ICC 2000) (Figures 1615 (1) and 1615(2) in the code) and depict maximum considered earthquake ground motion of 0.2 and 1.0 second spectral response acceleration, respectively, based on a 2 percent probability of exceedance in 50 years. Hanford lies within the 0.40 to 0.50 g mapping contours for a 0.2-second spectral response acceleration and the 0.10 to 0.15 g contours for a 1.0-second spectral response acceleration.

There is some potential for slope failure at Hanford, although only the slopes of Gable Mountain and White Bluffs are steep enough to warrant landslide concern. White Bluffs, east of the Columbia River, poses the greatest concern. This risk is in part attributable to the largely unconsolidated and uncemented nature of the Ringold sediments comprising much of the bluffs, the discharge of irrigation water atop the bluffs and subsequent percolation through the sediments, and the general dip of the sediments toward the Columbia River (DOE 1999k:4-18, 4-21; Neitzel 1999:4.43). A large landslide along White Bluffs could fill the Columbia River channel and divert water onto Hanford. Calculations of the potential impacts of such a landslide indicate a flood area similar to the probable maximum flood (Neitzel 1999:4.64, 4.65).

Several major volcanoes are in the Cascade Range west of Hanford, including Mount Adams and Mount St. Helens, located 165 kilometers (102 miles) and 220 kilometers (137 miles) from the site, respectively. Ashfalls from at least three Cascade volcanoes have blanketed the central Columbia Plateau since the late

Pleistocene epoch. Generally, ashfall layers have not exceeded more than a few centimeters in thickness, with the exception of the Mount Mazama (Crater Lake, Oregon) eruption, when as much as 10 centimeters (3.9 inches) of ash fell over western Washington (Barghusen and Feit 1995:2.2-14).

Fifteen different soil types occur at Hanford. These soils vary from sand to silty and sandy loam. The dominant soil types are the Quincy (Rupert) sand, Burbank loamy sand, Ephrata sandy loam, and the Warden silt loam. No soils at Hanford are currently classified as prime farmlands because there are no current soil surveys, and the only prime farmland soils in the region are irrigated. The Quincy (Rupert) sand is the most widespread soil type at Hanford, but particularly encompasses much of the southeast and east-central portions of the site (south and east of the 200 Areas). It developed from sandy alluvial deposits mantled by wind-blown sand. Burbank loamy sand soils mainly occur north of the 200 Areas and south of the Columbia River along with Ephrata sandy loams. Both soils are underlain by gravelly material. The Warden silt loam occurs in a broad band in the south and southwestern portions of the site, running from the south boundary of the site and downslope of Rattlesnake Mountain (DOE 1999k:4.23–4.27; Neitzel 1999:4.48–4.51). More detailed descriptions of the geology and the soil conditions at Hanford are included in the *Hanford Site NEPA Characterization* (Neitzel 1999) and the *Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999k).

3.4.5.2 Locations of Proposed Activities

300 AREA

The Central Gable Mountain fault is the nearest capable fault to the 300 Area and is located 28 kilometers (17 miles) away (DOE 1999k:4-19; Mecca 1997a:6, 78, 79). The predominant soil type is the Quincy (Rupert) sand (Neitzel 1999:4.49).

400 AREA

The nearest capable fault to the 400 Area (Central Gable Mountain fault) is 19 kilometers (12 miles) away. The predominant soil type in the 400 Area is the Quincy (Rupert) sand, and the soils are not subject to liquefaction or other instabilities (Mecca 1997a:6, 78, 79; Neitzel 1999:4.49).

3.4.6 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Material presented in this section, unless otherwise noted, is from the *Storage and Disposition PEIS* (DOE 1996b:3-83-3-87).

3.4.6.1 Terrestrial Resources

This section addresses the plant and animal communities of Hanford and includes a plant community map of the site. Terrestrial resources are described for the site as a whole, as well as for the proposed facility locations.

3.4.6.1.1 General Site Description

Vegetation at Hanford has been characterized as shrub-steppe. Shrub-steppe ecosystems are typically dominated by a shrub overstory with a grass understory. Present site development consists of clusters of large buildings that are found at widely spaced locations. Developed areas encompass about 6 percent of the site. The remaining areas of the site can be divided into 10 major plant communities (**Figure 3–9**). Hanford is dominated by communities in which big sagebrush is a major component. Other plant communities contain

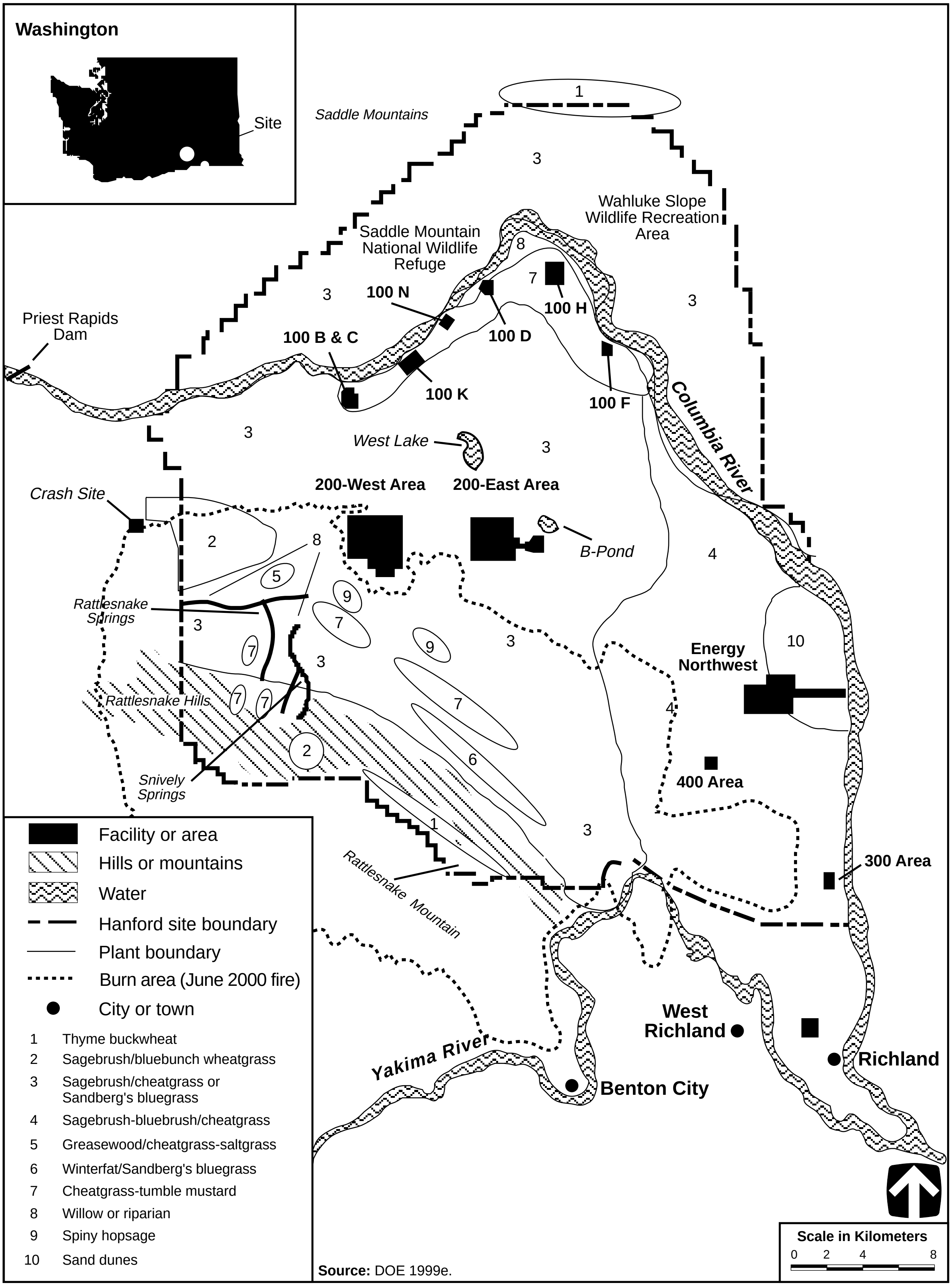

Figure 3–9 Distribution of Plant Communities at the Hanford Site

a variety of grasses and herbaceous plants. Areas previously disturbed by agricultural activities are dominated by nonnative species, such as cheatgrass. Trees are uncommon on the site, but those that are present include cottonwood and willow, which are both found near water bodies, and a few other deciduous species which were originally planted near farmsteads as windbreaks. Five hundred ninety species of plants have been identified at Hanford (Neitzel 1999).

Unique habitats on the Hanford Site include bluffs, dunes, and islands within the Columbia River. The White Bluffs, Umtanum Ridge, and Gable Mountain include rock outcrops that occur infrequently on the site. Vegetation on basalt outcrops includes snow buckwheat and Sandberg's bluegrass. The terrain of the dune habitat rises and falls between 3 and 5 meters (10 and 16 feet). The dune are vegetated by bitterbrush, dune scurfpea, and thickspike wheatgrass. Riparian vegetation that characterizes the islands of the Columbia River includes willow, white mulberry, snow buckwheat, lupine, yarrow, and thickspike wheatgrass among others (Neitzel 1999).

Hanford provides suitable habitat for numerous animal species, including over 1,500 species of insects, 4 species of amphibians, 9 species of reptiles, 246 species of birds, and 40 species of mammals. Grasshoppers and darkling beetles are among the more conspicuous groups of insects, and along with other insects, are an important food source for local birds and mammals (Neitzel 1999:4.87). Common animal species at Hanford include the side-blotched lizard, gopher snake, western meadowlark, horned lark, Great Basin pocket mouse, black-tailed jackrabbit, and mule deer. Trees planted around former farmsteads serve as nesting platforms for several species of birds, including hawks, owls, ravens, magpies, and great blue herons; these trees also serve as night roosts for bald eagles. The Hanford Reach of the Columbia River, including several sparsely vegetated islands, provides nesting habitat for the Canada goose, ring-billed gull, Forester's tern, and great blue heron. Several game animals are found at Hanford. Hunting is permitted on site north of the Columbia River. Numerous raptors, such as the Swainson's hawk and red-tailed hawk, and carnivores, such as the coyote and bobcat, are found on Hanford. A variety of migratory birds have been found at Hanford.

Unique habitats on the Hanford Site provide habitat for a number of species of wildlife. Bluff areas provide nesting habitat for prairie falcons, red-tailed hawks, and several species of swallows and roosting habitat for bald eagles. Mule deer, burrowing owls, and coyotes, as well as many transient species, may be found in dune habitat. Islands in the Columbia River provide nesting habitat for Canada geese, California gulls, ring-billed gulls and Forster's tern (Neitzel 1999).

Between June 27 and July 1, 2000, a wildfire fanned by high winds burned a large portion of the Hanford Site, including lands within the Hanford Reach National Monument and most of the Arid Lands Ecology Reserve (Figures 3–6 and 3–9). The total burn area encompasses an estimated 474,432 hectares (192,000 acres) and is reported to rank among the largest in Washington State history. The burn area is depicted on Figure 3–9. The fire was ignited by a fatal automobile crash that occurred on State Route 24 during the afternoon of June 27, 2000.

The immediate effect on ecological resources on the Hanford Site, aside from plants and animals that perished as a direct result of the fire, is the displacement of animals from their habitat. This is especially true of species largely dependent on the unique shrub-steppe ecosystem. For example, elk that normally reside within the Arid Lands Ecology Reserve have begun to roam in search of forage. A longer-term concern for plant communities affected by fire and animals dependent on them is that nonnative, invasive plant species may now have a better competitive advantage at the expense of the native grasses and sagebrush. A fire recovery plan is being drafted and ecological monitoring and field studies are likely to be conducted to determine the fire's aftermath and success of recovery efforts.

3.4.6.1.2 Locations of Proposed Activities

300 AREA

While the 300 Area is located within the big sagebrush/bunchgrasses–cheatgrass vegetation community, it is heavily developed (DOE 1999k). Vegetation within the 300 Area is characteristic of disturbed areas consisting of sparse amounts of cheatgrass and Russian thistle (Nielsen 2000). Due to the disturbed nature of most of the 300 Area, wildlife use of developed portions of the areas is limited.

400 AREA

The 400 Area is located within postfire shrub-steppe habitat dominated by cheatgrass and small shrubs, including gray and green rabbitbrush. Due to past disturbances and human occupancy in the 400 Area, wildlife is limited. Several animal species may be found in the area, including the gopher snake, northern Pacific rattlesnake, burrowing owl, Swainson's hawk, western meadowlark, black-tailed jackrabbit, and Great Basin pocket mouse (DOE 1999e:3-35).

3.4.6.2 Wetlands

Wetlands include "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR Section 328.3). Wetlands are described for Hanford as a whole, as well as for the proposed facility locations.

3.4.6.2.1 General Site Description

Primary wetland areas at Hanford are found in the riparian zone along the Columbia River. The extent of this zone varies, but includes large stands of willows, grasses, and other plants. This area has been extensively affected by hydropower operations at Priest Rapids Dam (Neitzel 1999).

Other large areas of wetlands at Hanford can be found north of the Columbia River within the Saddle Mountain National Wildlife Refuge and the Wahluke Wildlife Unit Columbia Basin Area. These two areas encompass all the lands extending from the north bank of the Columbia River northward to the site boundary and east of the Columbia River down to Ringold Springs. Wetland habitat in these areas consists of fairly large ponds resulting from irrigation runoff. These ponds have extensive stands of cattails and other emergent aquatic vegetation surrounding the open water regions. They are extensively used as nesting sites by waterfowl (Neitzel 1999).

On the western side of Hanford, Rattlesnake Springs supports a riparian zone of 2.5 kilometers (1.6 miles) in length, featuring watercress, bulrush, spike rush, cattail and peachleaf willow. Snively Springs also contains a diverse biotic community similar to Rattlesnake Springs. Several semi-permanent artificial ponds and ditches that receive cooling water or irrigation wastewater are also present on Hanford. These waterbodies provide a source of water for terrestrial animals (Neitzel 1999).

3.4.6.2.2 Locations of Proposed Activities

300 AREA

The 300 Area is bounded on the eastern side by the Columbia River. The riparian zone bordering the river is the only wetland area associated with the site (Nielsen 2000). The general nature of this zone is discussed in Section 3.4.6.2.1.

400 AREA

There are no natural wetlands in the 400 Area, although a small cooling and wastewater pond does contain some wetland vegetation. Wildlife species observed using the site include a variety of mammals and waterfowl (DOE 1999e:3-36).

3.4.6.3 Aquatic Resources

Aquatic resources at Hanford are described for the site as a whole, as well as for the proposed facility locations.

3.4.6.3.1 General Site Description

Aquatic resources on Hanford include the Columbia River, ephemeral streams, springs, surface ponds, and ditches. The Columbia River flows along the northern and eastern edges of the site. The Hanford Reach supports 44 anadromous and resident species of fish. Many of the fish species present in the Hanford Reach are dependent upon flowing water and rocky substrate for at least part of their life cycles. Fall chinook salmon, steelhead trout, mountain whitefish, and smallmouth bass spawn in this area. The destruction of other mainstream Columbia River spawning areas by dams has increased the relative importance of the Hanford Reach for spawning (Neitzel 1999).

The Hanford Reach provides a migration route to upstream spawning areas for spring, summer, and fall adult chinook salmon, coho salmon, sockeye salmon, and steelhead trout. It also provides rearing habitat for the salmonid juveniles in their downstream migration to the sea. Principal resident fish species sought by anglers in the Hanford Reach include mountain whitefish, white sturgeon, smallmouth bass, crappie, catfish, walleye, and yellow perch (Neitzel 1999).

The Yakima River borders the southern portion of Hanford. Game fish found in the river in the vicinity of the site are smallmouth bass, steelhead trout, and channel catfish. Cold Creek and its tributary, Dry Creek, are ephemeral streams within the Yakima River drainage system along the southern boundary of Hanford. These streams do not support any fish populations.

There are several springs at Hanford. Rattlesnake Springs and Snively Springs, which are in the western portion of the site, form short streams that seep into the ground. None of the springs support any fish populations.

3.4.6.3.2 Locations of Proposed Activities

300 AREA

The 300 Area is immediately to the west of the Columbia River. There are no aquatic resources on the site itself (Nielsen 2000).

400 AREA

Although no natural aquatic habitat occurs in the 400 Area, a small cooling and wastewater pond is present (DOE 1999e:3-36). The 400 Area is 6.8 kilometers (4.2 miles) west of the Columbia River.

3.4.6.4 Threatened and Endangered Species

Endangered species are those plants and animals in danger of extinction throughout all or a large portion of their range. Threatened species are those species likely to become endangered within the foreseeable future. Threatened and endangered species are described for Hanford as a whole, as well as for the proposed facility locations.

3.4.6.4.1 General Site Description

Eighty-one Federal- and state-listed threatened, endangered, and other special status species may be found on Hanford. These are listed in Tables 4–6 and 4–7 of the *Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999k). Nineteen of these are Federal- or state-listed as threatened or endangered, while the remainder are listed by the state within one of several special status classifications.

The threatened bald eagle, which has been proposed to be delisted, is the only federally listed species known to be found regularly at Hanford, although there are occasional sitings of the threatened Aleutian Canada goose. The bald eagle, which is also listed by the state as endangered, is a regular winter resident along the Hanford Reach where it forages for salmon and waterfowl. Trees in the historic Hanford Townsite area are used by eagles for perching. Recently, eagles have attempted to nest on the site. The peregrine falcon, listed as endangered by the state, is a migrant in the Hanford area (Dirkes and Hanf 1997:F.1; DOE 1996b :3-44; Neitzel 1999). The Upper Columbia River run of steelhead and Upper Columbia River spring run of Chinook salmon are listed as endangered and the Middle Columbia River run of steelhead are listed as threatened by the Federal government. Spring-run chinook salmon do not spawn in the Hanford Reach but use it as a migration corridor. Little is known about the quality and quantity of steelhead spawning, rearing, and adult holding habitat in the Hanford Reach and Upper Columbia River (DOE 1999k). Recently, the Hanford Reach has been designated as critical habitat for Upper Columbia River spring-run chinook salmon and Upper Columbia River steelhead (65 FR 7764). Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service and National Marine Fisheries Service. Consultation has also been initiated with the state.

3.4.6.4.2 Locations of Proposed Activities

300 AREA

A survey of the 300 Area made in conjunction with an environmental assessment of RPL did not locate any Federal- or state-listed threatened or endangered plant or animal species within the site (DOE 1997d). However, more recently, the peregrine falcon and bald eagle have been observed in the area (Nielsen 2000).

400 AREA

No Federal- or state-listed threatened or endangered plants or animals reside in the vicinity of the 400 Area (DOE 1999e), although potential exists for the incidental occurrence of some migratory species, such as the peregrine falcon. State sensitive plant species have not been found in the 400 Area, although Piper's daisy does occur in the vicinity. A fire also burned the area in the mid 1980s, leaving it dominated by cheatgrass and some small shrubs (Mecca 1997b; Schinner 1999).

3.4.7 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. The three general categories of cultural resources addressed in this section are prehistoric, historic, and Native American. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age, and may be sources of information on paleoenvironments and the evolutionary development of plants and animals.

Hanford has a well-documented record of cultural and paleontological resources. The *Hanford Cultural Resources Management Plan* (Battelle 1989), establishes guidance for identifying, evaluating, recording, curating, and managing these resources. There are approximately 930 cultural resource sites and isolated finds recorded (Neitzel 1999:4.104). Forty-eight archaeological sites and one building are included on the National Register of Historic Places. Nominations have been prepared for several archaeological districts and sites considered to be eligible for listing on the National Register. While many significant cultural resources have been identified, only about 6 percent of the Hanford Site has been surveyed, and few of the known sites have been evaluated for their eligibility for listing on the National Register. Cultural resource reviews are conducted whenever projects are proposed in previously unsurveyed areas. In recent years, reviews have exceeded 500 per year.

Cultural sites are often occupied continuously or intermittently over substantial time spans. For this reason, a single location may contain evidence of use during both historic and prehistoric periods. In the discussions that follow, the numbers of prehistoric and historic resources are presented. The sum of these resources may be greater than the total number of sites reported due to this dual-use history at sites. Therefore, where the total number of sites reported is less than the sum of prehistoric and historic sites, certain locations were used during both periods.

3.4.7.1 Prehistoric Resources

Prehistoric resources are physical properties that remain from human activities that predate written records.

3.4.7.1.1 General Site Description

About 365 prehistoric archaeological sites and isolated finds have been recorded on Hanford. Of 48 sites included on the National Register of Historic Places, two are individual sites (Hanford Island Site and Paris Site), and the remainder are located in seven archaeological districts. In addition, four other archaeological districts have been nominated or are planned to be nominated for the National Register. A number of sites have been identified along the Middle Columbia River and in inland areas away from the river, but near other water sources. Some evidence of human occupation has been found in the arid lowlands. Sites include remains of numerous pithouse villages, various types of open campsites, graves along the riverbanks, spirit quest monuments (rock cairns), hunting camps, game drive complexes, quarries in mountains and rocky bluffs, hunting and kill sites in lowland stabilized dunes, and small temporary camps near perennial sources of water away from the river (Neitzel 1999).

More than 10,000 years of prehistoric human activity in the largely arid environment of the Middle Columbia River region have left extensive archaeological deposits. Archaeological surveys have been conducted at Hanford since 1926; however, little excavation has been conducted at any of the sites. Surveys have included studies of Gable Mountain, Gable Butte, Snively Canyon, Rattlesnake Mountain, Rattlesnake Springs, and a portion of the Basalt Waste Isolation Project Reference Repository location. Most of the surveys have focused on islands and on a 400-meter (1,312-foot) wide area on either side of the river. From 1991 through 1993, the 100 Areas were surveyed, and new sites were identified. Excavations have been conducted at several sites on the riverbanks and islands and at two unnamed sites. Test excavations have been conducted at the Wahluke, Vernita Bridge, and Tsulim sites and at other sites in Benton County (Neitzel 1999).

3.4.7.1.2 Locations of Proposed Activities

300 AREA

Much of the 300 Area has been highly disturbed by industrial activities and is unlikely to contain intact prehistoric sites (Neitzel 1999). The *Hanford Cultural Resources Management Plan* (Battelle 1989) provides for survey work before construction, and has contingency guidelines for handling the discovery of previously unknown archaeological resources encountered during construction.

400 AREA

Most of the 400 Area has been highly disturbed and is unlikely to contain intact prehistoric sites. A cultural resources survey found only 12 hectares (30 acres) that were undisturbed, and no sites were identified either within the 400 Area or within 2 kilometers (1.2 miles) of the 400 Area. The *Hanford Cultural Resources Management Plan* (Battelle 1989) provides for survey work before construction, and has contingency guidelines for handling the discovery of previously unknown archaeological resources encountered during construction.

3.4.7.2 Historic Resources

Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are generally considered to be those that date no earlier than 1492.

3.4.7.2.1 General Site Description

Five hundred seventeen historic archaeologic sites associated with the pre-Hanford Site and the Cold War eras, including an assortment of farmstead, corrals, dumps, and military sites, have been recorded since 1977 (Neitzel 1999). Of these sites, one is included on the National Register of Historic Places as a historic site, and 56 are listed as archaeological sites. Sites and localities that predate the Hanford era include homesteads, ranches, trash scatters, dumps, gold mine tailings, roads, and townsites, including the Hanford townsite and the East White Bluffs townsite and ferry landing. More recent historic structures include the defense reactors and associated materials-processing facilities that played an important role in the Manhattan Project and the Cold War era. A Programmatic Agreement for the maintenance, deactivation, alteration, and demolition of the built environment on Hanford has been reached between DOE, the Advisory Council on Historic Preservation, and the Washington State Historic Preservation Office (DOE 1996d).

Lewis and Clark were the first European Americans to visit the Hanford region during their 1804 to 1806 expedition. They were followed by fur trappers, military units, and miners. It was not until the 1860s that merchants set up stores, a freight depot, and the White Bluffs Ferry on the Hanford Reach, and Chinese gold miners began to work the gravel bars. Cattle ranches opened in the 1880s, and farmers soon followed. Several small thriving towns, including Hanford, White Bluffs, and Ringold, grew up along the riverbanks in the early 20th century. Other ferries were established at Wahluke and Richland. These towns, and nearly all other structures, were razed after the U.S. Government acquired the land for the original Hanford Engineer Works in the early 1940s (part of the Manhattan Project). Plutonium produced at the 100 B-Reactor was used in the first nuclear explosion at the White Sands Missile Range in New Mexico, and later in the bomb that destroyed Nagasaki, Japan, to help end World War II. The Hanford 100 B-Reactor is listed on the National Register and is designated a National Mechanical Engineering Landmark, a National Historic Civil Engineering Landmark, and a National Nuclear Engineering Landmark. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office.

3.4.7.2.2 Locations of Proposed Activities

300 AREA

The 300 Area has been highly disturbed by industrial activities. Five recorded archaeological sites, including campsites, housepits, and historic trash scatter, are located at least partially within the 300 Area; many more may by located in subsurface deposits. Twenty-seven archaeological sites and 13 isolated artifacts have been recorded within 2 kilometers (1.2 miles) of the site. The historic archaeological sites contain debris scatters and roadbeds associated with farmsteads. One site has been tested and is recognized as eligible for listing on the National Register of Historic Places. One hundred fifty-eight buildings or structures in the 300 Area have been inventoried and of that number, 47 have been determined eligible for the National Register as contributing properties within the Historic District recommended for mitigation, including RPL/306–E (DOE 1996d; Neitzel 1999).

400 AREA

Most of the 400 Area has been so disrupted by construction activities, that a 1978 archaeological survey found only 12 hectares (30 acres) that were undisturbed. No cultural resources were located in those 12 hectares (30 acres). No archaeological sites are known to be located within 2 kilometers (1.2 miles) of the 400 Area.

All of the building and structures in the 400 Area were constructed during the Cold War era. Six buildings/structures have been determined eligible for the National Register of Historic Places as contributing properties within the Historic District recommended for mitigation. These include the 405 Reactor Containment Building, 436 Training Facility, 4621-W Auxiliary Equipment Facility, 4703 Fast Flux Test Facility Control Building, 4710 Operation Support Building, and the 4790 Patrol Headquarters (DOE 1996d).

3.4.7.3 Native American Resources

Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. In addition, cultural values are placed on natural resources such as plants, which have multiple purposes within various Native American groups. Of primary concern are concepts of sacred space that create the potential for land use conflicts.

3.4.7.3.1 General Site Description

In prehistoric and early historic times, Native Americans of various tribal affiliations heavily populated the Hanford Reach. The Wanapum and the Chamnapum bands of the Yakama Nation lived along the Columbia River at what is now Hanford. Some of their descendants still live nearby at Priest Rapids, northwest of Hanford. Palus People, who lived on the lower Snake River, joined the Wanapum and Chamnapum to fish the Hanford Reach, and some inhabited the east bank of the river. Walla Walla and Umatilla People also make periodic visits to fish in the area. These people retain traditional secular and religious ties to the region, and many have knowledge of the ceremonies and lifeways of their culture. The Washani, or Seven Drums religion, which has ancient roots and originated among the Wanapum, is still practiced by many people on the Yakama, Umatilla, Warm Springs, and Nez Perce Reservations. Native plant and animal foods, some of which can be found at Hanford, are used in the ceremonies performed by tribal members.

Consultation is required, and has been initiated, to identify the traditional cultural properties that are important in maintaining the cultural heritage of Native American tribes. Under separate treaties signed in 1855, the Confederated Tribes and Bands of the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation ceded lands to the United States that include the present Hanford Site. Under the treaties, the tribes reserved the right to fish at usual and accustomed places in common with the citizens of the territory, and retained the privilege of hunting, gathering roots and berries, and pasturing horses and cattle upon open, unclaimed land. The Treaty of 1855 with the Nez Perce Tribe includes similar reservations of rights, and the Nez Perce have identified the Hanford Reach as the location of usual and accustomed places for fishing. The Wanapum People are not signatory to any treaty with the United States and are not a federally recognized tribe; however, they live about 8 kilometers (5 miles) west of the Hanford boundary, they were historical residents of Hanford, and their interests in the area have been acknowledged.

All of these tribes are active participants in decisions regarding Hanford and have expressed concerns about hunting, fishing, pasture rights, and access to plant and animal communities and important sites. Sites sacred to Native Americans at Hanford include remains of prehistoric villages, burial grounds, ceremonial longhouses or lodges, rock art, fishing stations, and vision quest sites. Culturally important localities and geographic features include Rattlesnake Mountain, Gable Mountain, Gable Butte, Goose Egg Hill, Coyote Rapids, and the White Bluffs portion of the Columbia River.

3.4.7.3.2 Locations of Proposed Activities

300 AREA

One documented locality with great importance to the historic Wanapum is near the 300 Area. Certain areas near the 300 Area have been found to be of great importance to Native Americans and are fenced (Neitzel 1999).

400 AREA

The 400 Area is not known to contain any Native American resources.

3.4.7.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age.

3.4.7.4.1 General Site Description

Remains from the Pliocene and Pleistocene Ages have been identified at Hanford. The Upper Ringold Formation dates to the Late Pliocene Age and contains fish, reptile, amphibian, and mammal fossil remains. Late Pleistocene Touchet beds have yielded mammoth bones. These beds are composed of fluvial sediments deposited along ridge slopes that surround Hanford.

3.4.7.4.2 Locations of Proposed Activities

300 AREA

Paleontological resources are limited in the vicinity of the 300 Area, and no such resources have been located within the site itself (Nielsen 2000).

400 Area

No paleontological resources have been reported in the 400 Area. Late Pleistocene Touchet beds, which have yielded mammoth bones, are located at distances greater than 5 kilometers (3.1 miles) from the 400 Area.

3.4.8 Socioeconomics

Statistics for employment and regional economy are presented for the regional economic area, as defined in Appendix G.8, which encompasses nine counties surrounding Hanford in Washington. Statistics for population, housing, community services, and local transportation are presented for the region of influence, a two-county area in which 91 percent of all Hanford employees reside (**Table 3–22)**. In 1997, Hanford employed 12,882 persons, 3.7 percent of the regional economic area civilian labor force (DOE 1999e).

Table 3–22 Distribution of Employees by Place of Residence in the Hanford Region of Influence, 1997

County	Number of Employees	Total Site Employment (percent)
Benton	10,563	82.0
Franklin	1,159	9.0
Region of influence total	11,722	91.0

Source: DOE 1999e.

3.4.8.1 Regional Economic Characteristics

Between 1990 and 1996, the civilian labor force in the regional economic area increased 35.3 percent, to the 1996 level of 344,611. In 1996, the annual unemployment average in the regional economic area was 11.1 percent, significantly higher than the annual unemployment average of 6.5 percent in Washington State (DOE 1999e).

In 1995, service activities represented the largest sector of employment in the regional economic area (22.3 percent). This was followed by agriculture (19.6 percent) and government (17.4 percent). Overall, the state total for these employment sectors was 25.0 percent, 3.7 percent, and 18.0 percent, respectively (DOE 1999e).

3.4.8.2 Population and Housing

In 1996, the region of influence population totaled 179,949. Between 1990 and 1996, the region of influence population increased 18.9 percent, compared with the 12.9 percent increase experienced in Washington. Between 1980 and 1990, the number of housing units in the region of influence increased by 4.6 percent, compared with a 20.3 percent increase in Washington. The 1990 homeowner vacancy rates for the region of influence was 1.4 percent, compared with the state’s rate of 1.3 percent. The region of influence renter vacancy rate was 5.5 percent, compared with 5.8 percent for the state (DOE 1999e).

3.4.8.3 Community Services

3.4.8.3.1 Education

In 1997, ten school districts providing public education in the Hanford region of influence were operating at capacities ranging from 65 to 100 percent. Total student enrollment in the region of influence in 1997 was 38,206 and the student-to-teacher ratio in the region of influence averaged 16:1. In 1990, the average student-to-teacher ratio for Washington was 11.4:1 (DOE 1999e).

3.4.8.3.2 Public Safety

In 1997, a total of 281 sworn police officers were serving the region of influence. The region of influence average officer-to-population ratio was 1.6 officers per 1,000 persons. This compares with the 1990 state average of 1.7 police officers per 1,000 persons. In 1997, 616 paid and volunteer firefighters provided fire protection services in the Hanford region of influence. The average firefighter-to-population ratio in 1997 in the region of influence was 3.4 firefighters per 1,000 persons. This compares with the 1990 state average of 1 firefighter per 1,000 persons (DOE 1999e).

3.4.8.3.3 Health Care

In 1996, a total of 257 physicians served the region of influence. The average physician-to-population ratio in the region of influence was 1.4 physicians per 1,000 persons compared with the 1996 state average of 3.7 per 1,000 persons. In 1997, there were four hospitals serving the region of influence. The hospital bed-to-population ratio averaged 2.1 beds per 1,000 persons. This compares with a state 1991 average of 2.4 beds per 1,000 persons (DOE 1999e).

3.4.8.4 Local Transportation

Vehicle access to Hanford is provided by State Routes 240, 243, and 24. State Route 240 connects to the Richland bypass highway, which interconnects with I–182. State Route 243 exits the site's northwestern boundary and serves as a primary link between the site and I–90. State Route 24 enters the site from the west and continues eastward across the northernmost portion of the site and intersects State Route 26 about 16 kilometers (10 miles) east of the site boundary (Figure 3–6) (DOE 1999e). Only routine preservation projects are planned by the Washington State Department of Transportation for the state routes listed above and are not considered to impact access into the site (Trepanier 2000).

The local intercity transit system, Ben Franklin Transit, supplies bus service between the Tri-Cities and Hanford, although bus service is provided only to the 300 Area and Energy Northwest. Both private interests and Ben Franklin Transit provide van pooling opportunities in the region of influence.

There is presently no rail service at Hanford, except for a spur to Energy Northwest. Onsite rail transport was formerly provided by a short-line railroad that connected with the Union Pacific line just south of the Yakima River. The Union Pacific line interchanges with the Burlington Northern-Santa Fe at the city of Kennewick. The Hanford railroad is still intact and service could be restored if needed.

In the region of influence, the Columbia River is used as an inland waterway for barge transportation from the Pacific Ocean. The Port of Benton provides a barge slip where shipments arriving at Hanford may be off-loaded.

Tri-Cities Airport, near the city of Pasco, provides jet air passenger and cargo service by both national and local carriers. Numerous smaller private airports are located throughout the region of influence (DOE 1999e).

3.4.9 Existing Human Health Risk

Existing human health risk issues include the determination of potentially adverse effects on human health that result from acute and chronic exposures to ionizing radiation and hazardous chemicals.

3.4.9.1 Radiation Exposure and Risk

3.4.9.1.1 General Site Description

Major sources and levels of background radiation exposure to individuals in the vicinity of Hanford are shown in **Table 3–23**. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population, in terms of person-rem, changes as the population size changes. Background radiation doses, as identified in Table 3–23, are unrelated to Hanford operations.

Table 3–23 Sources of Radiation Exposure to Individuals in the Hanford Vicinity Unrelated to Hanford Operations

Source	Effective Dose Equivalent (millirem per year)
Natural background radiation[a]	
Cosmic radiation	30
External terrestrial radiation	30
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other background radiation[b]	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	Less than 1
Air travel	1
Consumer and industrial products	10
Total	365

a. Battelle 1998:5.9.
b. NCRP 1987:11, 40, 53.
Note: Value of radon is an average for the United States.

Releases of radionuclides to the environment from Hanford operations provide another source of radiation exposure to individuals in the vicinity of Hanford. Types and quantities of radionuclides released from Hanford operations in 1997 are listed in the *Hanford Site Environmental Report for Calendar Year 1997* (Battelle 1998:4.10-4.14). Doses to the public resulting from these releases are presented in **Table 3–24**. These doses fall within radiological limits per DOE Order 5400.5 and are much lower than those of background radiation.

Using a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Appendix H), the risk of a latent cancer fatality to the maximally exposed member of the public due to radiological releases from Hanford operations in 1997 is estimated to be 5.5×10^{-9}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of Hanford operations is less than 6 in 1 billion. It takes several to many years from the time of radiation exposure for a cancer to manifest itself.

According to the same risk estimator, 1×10^{-4} excess latent cancer fatality are projected in the population of 370,000 living within 80 kilometers (50 miles) of Hanford from normal operations in 1997. To place this number in perspective, it may be compared with the number of cancer fatalities expected in the same population from all causes. The 1997 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year. Based on this mortality rate, the number of cancer fatalities expected during 1997 from all causes in the population living within 80 kilometers (50 miles) of Hanford was 740. This expected number of cancer fatalities is much higher than the 1×10^{-4} latent cancer fatality estimated from Hanford operations in 1997.

Table 3–24 Radiation Doses to the Public from Normal Hanford Operations in 1997 (Total Effective Dose Equivalent)

Members of the Public	Atmospheric Releases[a]		Liquid Releases		Total	
	Standard[b]	Actual	Standard[b]	Actual	Standard[b]	Actual
Maximally exposed individual (millirem)	10	0.0034	4	0.0076[c]	100	0.011
Population within 80 kilometers (person-rem)[d]	None	0.13	None	0.072	100	0.20
Average individual within 80 kilometers (millirem)[e]	None	3.5×10^{-4}	None	1.9×10^{-4}	None	5.4×10^{-4}

a. Includes direct radiation dose from surface deposits of radioactive material.
b. The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10-millirem-per-year limit from airborne emissions is required by the Clean Air Act, and the 4-millirem-per-year limit is required by the Safe Drinking Water Act; for this NI PEIS, the 4-millirem-per-year value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. The total dose of 100-millirem-per-year is the limit from all pathways combined. The 100-person-rem value for the population is given in proposed 10 CFR Part 834, as published in 58 FR 16268. If the potential total dose exceeds the 100-person-rem value, it is required that the contractor operating the facility notify DOE.
c. Includes the drinking water dose.
d. Based on a population of about 370,000 in 1997.
e. Obtained by dividing the population dose by the number of people living within 80 kilometers (50 miles) of the site.
Source: Battelle 1998:chap. 5.

Hanford workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. The average dose to the individual worker and the cumulative dose to all workers at Hanford from operations in 1997 are presented in **Table 3–25**. These doses fall within the radiological regulatory limits of 10 CFR Part 835. According to a risk estimator of 400 cancer fatalities per 1 million person-rem among workers[1] (Appendix H), the number of projected latent cancer fatalities among Hanford workers from normal operations in 1997 is 0.094.

Table 3–25 Radiation Doses to Workers from Normal Hanford Operations in 1997 (Total Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average radiation worker (millirem)	None[b]	114
Total workers (person-rem)[c]	None	235

a. The radiological limit for an individual worker is 5,000 millirem per year. However, DOE's goal is to maintain radiological exposure as low as is reasonably achievable. It has therefore established the Administrative Control Level of 2,000 millirem per year; the site must make reasonable attempts to maintain individual worker doses below this level.
b. No standard is specified for an "average radiation worker"; however, the maximum dose that this worker may receive is limited to that given in footnote "a."
c. 2,058 with measurable doses in 1997.
Source: DOE 1999d, 10 CFR Section 835.202.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Hanford Site Environmental Report for Calendar Year 1997* (Battelle 1998). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (on and off site) are also presented in that report.

[1] The risk estimator for workers is lower than the estimator for the public because of the absence from the workforce of the more radiosensitive infant and child age groups.

3.4.9.1.2 Locations of Proposed Activities

300 AREA

External radiation doses have been measured in the 300 Area. In 1997, the annual dose in the 300 Area was about 80 millirem. This is about 7 millirem higher than the value measured at the off site control locations. This onsite dose affects workers only, and is well below limits identified in Table 3–25. No measurements of plutonium concentrations in air were reported for the 300 Area (Battelle 1998:4-7 to 4-14, 4-76, 4-77).

400 AREA

External radiation doses have been measured in the 400 Area. In 1997, the annual dose in the 400 Area was about 81 millirem. This is about 8 millirem higher than the value measured at the offsite control locations. This onsite dose affects workers only, and is well below limits identified in Table 3–25. No measurements of plutonium concentrations in air were reported for the 400 Area (Battelle 1998:4-7 to 4-14, 4-76, 4-77).

3.4.9.2 Chemical Environment

The background chemical environment important to human health consists of the atmosphere which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media through which people may come in contact with hazardous chemicals (e.g., surface water during swimming, soil through direct contact, or food). Hazardous chemicals can cause cancer and noncancer health effects.

Carcinogenic Effects. Health effects in this case are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogenic. This could be incremental or excess individual lifetime cancer risk.

Noncarginogenic Effects. Health effects in this case are determined by the ratio between the calculated or measured concentration of the chemical in the air and the reference concentration or dose. This ratio is known as the Hazard Quotient. Hazard Quotients for noncarcinogens are summed to obtain the Hazard Index. If the Hazard Index is less than 1, no adverse health effects would be expected.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., air emissions and NPDES permit requirements) contribute to minimizing health impacts on the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts on the public may occur by inhaling air containing hazardous chemicals released to the atmosphere during normal Hanford operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are lower than those via the inhalation pathway.

Baseline air emission concentrations and applicable standards for hazardous chemicals are addressed in Section 3.4.3. The baseline concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations.

Exposure pathways to Hanford workers during normal operations may include inhaling contaminants in the workplace atmosphere and direct contact with hazardous materials. The potential for health impacts varies among facilities and workers, and available information is insufficient for a meaningful estimate of impacts. However, workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, substitution, and engineering and management controls. They are also protected by adherence to OSHA and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals used in the operational processes ensures that these standards are not exceeded. Additionally, DOE requires that conditions in the workplace be as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm.

3.4.9.3 Health Effects Studies

Three epidemiological studies and a feasibility study have been conducted on communities around Hanford to determine whether there are excess cancers in the general population. One study found no excess cancers but identified an elevated rate of neural tube defects in offspring. This elevated rate was not attributed to parental employment at Hanford. A second study suggested that neural tube defects were associated with cumulative radiation exposure, and showed other defects statistically associated with parental employment at Hanford, but not with parental radiation exposure. The third study did not show any cancer risk associated with living near the facility.

Many epidemiological studies have been carried out on the Hanford workers over the years. The studies have consistently shown a statistically significant elevated risk of death from multiple myeloma associated with radiation exposure among Hanford male workers. The elevated risk was observed only among workers exposed to 10 rads (~10 rem) or more. Other studies have also identified an elevated risk of death from pancreatic cancers, but a recent reanalysis did not conclude there was an elevated risk. Studies of female Hanford workers have shown an elevated risk of deaths from musculoskeletal system and connective tissue conditions. For a more detailed description of the studies reviewed and their findings, and for a discussion of the epidemiologic surveillance program implemented by DOE to monitor the health of current workers, refer to Appendix M.4.2 of the *Storage and Disposition PEIS* (DOE 1996b:M-224–M-230).

3.4.9.4 Accident History

Prior to 1997, there were 128 nuclear process-related incidents with some degree of safety significance at Hanford over its period of operation. These do not include less significant instances of radioactivity release or contamination during normal operations, which have been the subject of other reviews. The 128 incidents fall into three significant categories, based on the seriousness of the actual or potential consequences.

Fifteen of the incidents were Category 1, indicating that serious injury, radiation release or exposure above limits, substantial actual plant damage, or a significant challenge to safety resulted. Forty-six events were Category 2, less severe than Category 1, but involving significant cost or a less significant threat to safety. The remaining 67 incidents were Category 3, causing minor radiation exposure or monetary cost, or involving a violation of operating standards without a serious threat to safety. Descriptions of a sampling (three) of these incidents are presented in the following paragraphs.

On May 14, 1997, a chemical explosion occurred at the Hanford Plutonium Reclamation Plant in a room where nonradioactive bulk chemicals were mixed for the now-discontinued plutonium recovery process. The reclamation plant was designed to concentrate liquid feeds, dissolve and process solid material, and perform solvent-extraction recovery of plutonium from aqueous streams. Eight workers outside the plant at the time of the explosion complained of various symptoms, including headaches, light-headedness, and a strange metallic taste. All eight workers were transported to a nearby medical center, where they were examined and released. A small fire protection water line ruptured during the explosion, resulting in the release of water from the building. No one was injured and no radioactive materials were released to the environment. The explosion caused significant localized damage to the facility.

On April 14, 1998, a Pacific Northwest National Laboratory researcher performing work in the Building 324 facility, approached facility management and asked if they could turn off the tritium sampler in the main exhaust stack. The researcher was demonstrating the feasibility of treating components from dismantled nuclear weapons in a device called a plasma arc furnace and was concerned that the sampler would compromise classified information. B&W Hanford Company operated the facility, and Pacific Northwest National Laboratory conducted research as a tenant in the facility. The treatment of 200 components in the furnace ended up resulting in the release of up to about 20 curies of tritium through the facility stack. The Notice of Construction approved by the Washington State Department of Health had been modified to allow releasing 20 curies of tritium through the stack in support of this research; however, there were irregularities in the way the Notice of Construction modification was processed. It was later determined that the released quantity was within the limitation of the Notice of Construction, but the Washington State Department of Health still considered that other violations of the Washington Administrative Code may have occurred. On May 6, 1998, the Richland Operations Office Manager directed that the event be investigated. The investigation was to evaluate the sequence of events to identify causes and lessons learned (DOE 1998j).

On September 28 and 29, 1998, a biological vector (fruit flies) not previously identified with radioactive contamination within the DOE complex, spread contamination at the Hanford Site. The contamination was spread from a radioactive waste-transfer-piping diversion pit to clean refuse, which was then transported to the nearby municipal landfill for disposal. It was determined that workers and the public did not receive any radiation dose from this event (DOE 1999m).

3.4.9.5 Emergency Preparedness

Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program includes emergency planning, preparedness, and response.

Accordingly, the DOE Richland Operations Office has developed and maintains a comprehensive set of emergency preparedness plans and procedures for Hanford to support onsite and offsite emergency management actions in the event of an accident. The DOE Richland Operations Office also provides technical assistance to other Federal agencies and to state and local governments. Hanford contractors are responsible for ensuring that emergency plans and procedures are prepared and maintained for all facilities, operations, and activities under their jurisdiction, and for directing implementation of those plans and procedures during emergency conditions. The DOE Richland Operations Office, contractor, and state and local government plans are fully coordinated and integrated. Emergency control centers have been established by the DOE Richland Operations Office and its contractors for the principal work areas to provide oversight and support to emergency response actions within those areas.

Following the May 1997 explosion at Hanford discussed in Section 3.4.9.4, a review of the emergency management response indicated that multiple programs and systems failed in the hours following the accident. In a letter to Secretarial Offices, Secretary of Energy Federico Peña identified actions to be taken at all DOE sites for implementing lessons learned from the emergency response. The actions involve the following elements:

- Improve training for facility and site emergency personnel.
- Ensure that equipment and qualified personnel are ready for the wide variety of potential radiological and chemical hazards.
- Improve coordination with local medical communities.
- Have in place comprehensive procedures to attend to personnel who are potentially affected by an accident.

3.4.10 Environmental Justice

Under Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, Federal agencies are responsible for identifying and addressing the possibility of disproportionately high and adverse health, economic, and environmental impacts of programs and activities on minority and low-income populations in potentially affected areas. Minority populations refer to persons of any race self-designated as Asian, Black, Native American, or Hispanic. Low-income populations refer to households with incomes below the Federal poverty thresholds. In the case of Hanford, the potentially affected area includes parts of Washington and Oregon.

The potentially affected area surrounding the 400 Area is defined by a circle with an 80-kilometer (50-mile) radius centered at FMEF (latitude 46° 26'7" N, longitude 119° 21'55" W). The total population residing within that area in 1990 was 277,515; minorities made up 25.4 percent of the total population (DOE 1999e). In 1990, approximately one-fourth of the total national population was comprised of persons self-designated as members of a minority group, and minorities made up 13.2 percent of Washington State's total population and 9.2 percent of Oregon's total population.

According to the 1990 census, the racial and ethnic composition of the minority population in the potentially affected area around FMEF are as follows: Hispanics were the largest minority group, constituting 21.5 percent of the total population; Asians comprised 1.4 percent of the total population, Native Americans 1.4 percent, and Blacks 1.0 percent (DOE 1999e).

In 1990, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 45,820 persons, 17.3 percent of the total population, residing within the potentially affected area around the 400 Area reported incomes below the poverty threshold. Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold, corresponding percentages for Washington and Oregon were 10.9 and 12.4 percent, respectively.

3.4.11 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE activities. The waste is managed using appropriate treatment, storage, and disposal technologies and in compliance with all applicable Federal and state statutes and DOE orders.

3.4.11.1 Waste Inventories and Activities

Hanford manages the following types of waste: high-level, transuranic, mixed transuranic, low-level radioactive, mixed low-level radioactive, hazardous, and nonhazardous. Waste generation rates and the inventory of stored waste from activities at Hanford are provided in **Table 3–26**. Because high-level radioactive waste would not be generated by the proposed plutonium-238 production, new medical and industrial isotope production, or new nuclear research and development activities at Hanford, it is not included in this table or discussed any further in this section. The Hanford waste management capabilities are summarized in **Table 3–27**. More detailed descriptions of the waste management system capabilities at Hanford are included in the *Storage and Disposition PEIS* (DOE 1996b:3-61, E-12).

EPA placed Hanford on the National Priorities List on November 3, 1989. In accordance with CERCLA, DOE entered into a Tri-Party Agreement with EPA and the Washington State Department of Ecology to govern the environmental compliance and cleanup of Hanford. This agreement meets the legal requirements specified under the Federal Facility Compliance Act. An aggressive environmental restoration program is under way

Table 3–26 Waste Generation Rates and Inventories at Hanford

Waste Type	Generation Rate (cubic meters per year)	Inventory (cubic meters)
Transuranic and mixed transuranic		
Contact handled	450	11,450
Remotely handled	72	273
Low-level radioactive	3,902[a]	0
Mixed low-level radioactive		
RCRA	840	8,170
TSCA	7	103
Hazardous	560	NA[b]
Nonhazardous		
Liquid	200,000	NA[b]
Solid	43,000	NA[b]

a. Excludes waste from DOE environmental restoration activities.
b. Generally, hazardous and nonhazardous wastes are not held in long-term storage.
Note: To convert from cubic meters to cubic yards, multiply by 1.308.
Key: NA, not applicable; RCRA, Resource Conservation and Recovery Act; TSCA, Toxic Substances Control Act.
Source: DOE 1996e:15, 16, except high-level radioactive waste (DOE 1997a), hazardous and nonhazardous solid wastes (DOE 1996b:3-62, E-19), and nonhazardous liquid wastes (Teal 1997).

using priorities established in the Tri-Party Agreement (DOE 1996b:3-61). More information on regulatory requirements for waste disposal is provided in Chapter 5.

3.4.11.2 Transuranic and Mixed Transuranic Waste

All generated contact-handled transuranic waste is being placed in above-grade storage buildings at the Hanford Central Waste Complex (DOE 1996b:3-64). Transuranic waste will be maintained in storage until it is shipped to WIPP in Carlsbad, New Mexico, for disposal, beginning in July 2000 (Aragon 1999) or to a suitable geologic repository. The new Waste Receiving and Processing Facility has the capability to certify drummed or small container transuranic waste for shipment to WIPP (Dirkes and Hanf 1996:10). Transuranic wastes to be transported to WIPP will be packaged and shipped to WIPP for disposal in accordance with DOE and DOT requirements and WIPP waste acceptance criteria. Mixed transuranic wastes are included in the transuranic waste category because these wastes are expected to go to WIPP for ultimate disposal (DOE 1996b:3-64).

Table 3–27 Waste Management Capabilities at Hanford

Facility Name/ Description	Capacity	Status	Applicable Waste Type: TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
Treatment Facility (cubic meters per year except as otherwise specified)								
242-A Evaporator, cubic meters per day	265	Online	X	X	X	X		
Waste Receiving and Processing Facility	1,820	Online	X	X	X	X		
M91 Facility	Will be negotiated	Will be negotiated	X	X				
Thermal Treatment Facility Contract	5,135	Planned for 2001	X	X		X		
Grout Treatment Facility	15,000	Online				X		
Shielded Anlytical Lab Waste Treatment Unit, kilograms per hour	4	Online				X		
Maintenance & Storage Facility, batch per year	26	Online				X		
200 Area Liquid Effluent Treatment Facility, cubic meters per minute	0.57	Online			X	X		
200 East Area Sanitary Wastewater Treatment Facility	120,000	Online						X
Storage Facility (cubic meters)								
Central Waste Complex	16,800	Online	X	X	X	X		
Transuranic Waste Storage and Assay Facility	416	Standby	X	X	X	X		
305-B Storage Facility	20	Online			X	X	X	
B-Plant Canyon Waste Pile	5	Online			X			
B-Plant Container Storage	51	Online				X		
PUREX Tunnel 1	4,141	Online			X	X		
PUREX Tunnel 2	19,528	Online			X	X		
PUREX Canyon Waste Pile	432	Online				X		
200 Area Liquid Effluent Rentention Facility	59,000	Online			X	X		
4843 Alkali Metal Storage Facility	95	Standby				X	X	
Disposal Facility (cubic meters except as otherwise specified)								
Grout Vaults	230,000	Online			X			
Low-Level Radioactive Waste Burial Ground	1,740,000	Online			X			
Radioactive Mixed Waste Disposal Facility	14,200	Standby			X	X		
200 Area Treated Effluent Disposal Facility, cubic meters per minute	8.7	Online						X
Energy Northwest Sewage Treatment Facility, cubic meters per year	235,000	Online						X

Note: To convert from cubic meters to cubic yards, multiply by 1.308.
Key: Haz, hazardous; LLW, low-level radioactive waste; PUREX, Plutonium-Uranium Extraction (Plant); TRU, transuranic radioactive waste.
Source: DOE 1999e:3-10; Teal 1997.

3.4.11.3 Low-Level Radioactive Waste

Solid low-level radioactive waste is compacted and sent to the Low-level Radioactive Waste Burial Ground in the 200 West Area for disposal in trenches. Additional low-level radioactive waste is received from offsite generators and disposed of at the Low-level Radioactive Waste Burial Ground. Low-level radioactive waste resulting from the River Protection Project-tank waste treatment will be vitrified. The vitrified low-level radioactive waste will be disposed of on site in the 200 Area as part of the tank waste remediation system program (DOE 1996b:3-64). Low-level radioactive waste resulting from CERCLA cleanup activities are disposed of on site at the Environmental Restoration Disposal Facility.

U.S. Ecology operates a licensed commercial low-level radioactive waste Burial Ground on a site southwest of the 200-East Area that is leased to the State of Washington. The facility is not a DOE facility and is not considered part of DOE's Hanford operations (DOE 1996b:E-17).

3.4.11.4 Mixed Low-Level Radioactive Waste

Miscellaneous dilute aqueous low-level radioactive and liquid mixed low-level radioactive wastes are temporarily stored in the Liquid Effluent Retention Facility until treated in the Liquid Effluent Treatment Facility. The Liquid Effluent Retention Facility consists of three RCRA-compliant surface impoundments for storing process condensate from the 242-A Evaporator. This facility provides equalization of the flow and pH to the Liquid Effluent Treatment Facility. The Liquid Effluent Treatment Facility provides ultraviolet light/peroxide destruction of organic compounds, reverse osmosis to remove dissolved solids, and ion exchange to remove the last traces of contaminants. Discharge of the treated effluent is via a dedicated pipeline to an underground drain field. The effluent treatment process produces a mixed low-level radioactive waste sludge that is concentrated, dried, packaged in 208-liter (55-gallon) drums, and transferred to the Central Waste Complex. This secondary waste is stored prior to treatment, if necessary, and disposed in the Mixed Waste Trench (Dirkes and Hanf 1996:10, 45, 46).

The Waste Receiving and Processing Facility, near the Central Waste Complex in the 200 West Area, provides analyses, characterization, and preparation of drums and boxes for disposal of Hanford's mixed waste. The Waste Receiving and Processing Facility is designed to process 6,800 drums of waste annually and to prepare retrieved and stored transuranic waste for disposal (Dirkes and Hanf 1996:40).

The Radioactive Mixed Waste Disposal Facilities are in the Hanford Low-level Radioactive Waste Burial Ground and are designated as 218-W-5, Trench 31, and Trench 34. The facilities consist of rectangular trenches with approximate dimensions of 76 by 30 meters (250 by 100 feet). These facilities are RCRA compliant, with double liners and leachate collection and removal systems (Dirkes and Hanf 1996:40).

3.4.11.5 Hazardous Waste

There are no treatment facilities for hazardous waste at Hanford; therefore, the wastes are accumulated in satellite storage areas for less than 90 days, or at interim RCRA-permitted facilities, such as the 305-B Waste Storage Facility. The common practice for newly generated hazardous waste is to ship it off site by truck using DOT-approved transporters for treatment, recycling, recovery, and disposal at RCRA-permitted commercial facilities (DOE 1999e:3-11, 12).

3.4.11.6 Nonhazardous Waste

Sanitary wastewater is discharged to onsite treatment facilities such as septic tanks, subsurface soil adsorption systems, and wastewater treatment plants. These facilities treat an average of 600,000 liters (158,000 gallons) per day of sewage (DOE 1996b:E-19).

The 200 Area Treated Effluent Disposal Facility industrial sewer collects the treated wastewater streams from various plants in the 200 Areas and disposes of the clean effluent at two 2-hectare (5-acre) ponds permitted by the State of Washington (DOE 1996b:E-19). The design capacity of the facility is approximately 8,700 liters (2,300 gallons) per minute, although the discharge permit presently limits the average monthly flow to about 2,400 liters (640 gallons) per minute (Dirkes and Hanf 1996:46).

Nonhazardous solid wastes include construction debris, office trash, cafeteria wastes, furniture and appliances, nonradioactive friable asbestos, powerhouse ash, and nonradioactive/nonhazardous demolition debris. Until 1997, nonhazardous solid wastes were disposed of in the 600 Area central landfill. Under an agreement between DOE and the city of Richland, most of the site's nonregulated and nonradioactive solid wastes are now sent to the Richland Sanitary Landfill for disposal (DOE 1996b:3-65, E-19). The Richland Sanitary Landfill is at the southern edge of the Hanford Site boundary. Nonradioactive friable asbestos and medical waste are shipped off site for disposal to a commerical facility (DOE 1999e:3-12).

3.4.11.7 Waste Minimization

The Hanford Site Pollution Prevention Program is a comprehensive and continual effort to systematically reduce the quantity and toxicity of hazardous, radioactive, mixed, and sanitary wastes; conserve resources and energy; reduce hazardous substance use; and prevent or minimize pollutant releases to all environmental media from all operations and site cleanup activities. In accordance with sound environmental management, preventing pollution through source reduction is the first priority in the Hanford Site Pollution Prevention Program, and the second priority is environmentally safe recycling. Implementation of pollution prevention projects reduced the total amount of waste generated at Hanford in 1998 by approximately 17,500 cubic meters (23,000 cubic yards). Examples of pollution prevention projects completed in 1998 at Hanford include: the reduction of cleanup and stabilization of mixed low-level radioactive waste by approximately 170 cubic meters by decontaminating numerous items (including process tanks, machinery, floors, and associated equipment and piping) to low-level radioactive waste status, avoiding a mixed low-level radioactive wastestream and associated disposal costs; the reduction of hazardous waste by 22 metric tons (24 tons) by removing CFC-12 refrigerant from four of eight chillers and selling it to a vendor for reuse; and the reduction of cleanup and stabilization of mixed low-level radioactive waste by approximately 11 cubic meters (14 cubic yards) by recycling scrap metal from an underground tank system for use as radiation shielding blocks (DOE 1999f:64).

DOE has developed a draft *Waste Minimization and Management Plan for FFTF* to incorporate pollution prevention and waste minimization practices in its consideration of the future of FFTF (DOE 2000c). If a decision were made to restart FFTF, this plan would be used to ensure that optimum opportunities are provided for characterizing potential waste streams, identifying source reduction and recycling strategies, evaluating disposition options, developing sustainable designs, and implementing effective management strategies. This plan identifies DOE's preferred options for management, treatment, and/or disposition of all waste streams related to the restart and operation of FFTF. These preferred options primarily use commercial waste handling and disposal facilities.

3.4.11.8 Waste Management PEIS Records of Decision

The *Waste Management PEIS* Records of Decision affecting Hanford are shown in **Table 3–28** for the waste types analyzed in this NI PEIS. Decisions on the various waste types were announced in a series of Records of Decision that have been issued on the *Waste Management PEIS*. The transuranic waste Record of Decision was issued on January 20, 1998 (63 FR 3629); the hazardous waste Record of Decision was issued on August 5, 1998 (63 FR 41810); and the low-level radioactive waste Record of Decision was issued on February 18, 2000 (65 FR 10061). The transuranic waste Record of Decision states that DOE will develop and operate mobile and fixed facilities to characterize and prepare transuranic waste for disposal at WIPP.

Table 3–28 Waste Management PEIS Records of Decision Affecting Hanford

Waste Type	Preferred Action
Transuranic and mixed transuranic	DOE has decided that Hanford should prepare and store its transuranic waste on site pending disposal at WIPP or another suitable geologic repository.[a]
Low-level radioactive	DOE has decided to treat Hanford's low-level radioactive waste on site. Hanford could be selected as one of the regional disposal sites for low-level radioactive waste.[b]
Mixed low-level radioactive	DOE has decided to regionalize treatment at Hanford. This includes the onsite treatment of Hanford's wastes and could include treatment of some mixed low-level radioactive waste generated at other sites. Hanford has been selected as one of the regional disposal sites for mixed low-level radioactive waste.[b]
Hazardous	DOE has decided to continue to use commercial facilities for treatment of Hanford nonwastewater hazardous waste. DOE will also continue to use onsite facilities for wastewater hazardous waste.[c]

a. From the Record of Decision for transuranic waste (63 FR 3629).
b. From the Record of Decision for low-level radioactive and mixed low-level radioactive waste (65 FR 10061).
c. From the Record of Decision for hazardous waste (63 FR 41810).
Source: 63 FR 3629; 65 FR 10061; 63 FR 44810.

Each DOE site that has or will generate transuranic waste will, as needed, prepare and store its transuranic waste on site. The hazardous waste Record of Decision states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste, with ORR and SRS continuing to treat some of their own nonwastewater hazardous waste on site in existing facilities where this is economically favorable. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision states that for the management of low-level radioactive waste, minimal treatment will be performed at all sites, and disposal will continue, to the extent practicable, on site at INEEL, LANL, ORR, and SRS. In addition, Hanford and the Nevada Test Site will be available to all DOE sites for low-level radioactive waste disposal. Mixed low-level radioactive waste will be treated at Hanford, INEEL, ORR, and SRS, and disposed of at Hanford and the Nevada Test Site. More detailed information concerning DOE's alternatives for the future configuration of waste management facilities at Hanford is presented in the *Waste Management PEIS* and the transuranic waste, hazardous waste, and low-level radioactive and mixed low-level radioactive waste Records of Decision.

3.4.12 Spent Nuclear Fuel

When nuclear assemblies can no longer be used in the nuclear reactor, they are designated as "spent nuclear fuel," which is removed from the reactor and stored in the spent fuel storage pool or basin. The Nuclear Waste Policy Act of 1982, as amended, assigned the Secretary of Energy the responsibility for developing of a repository for the disposal of high-level radioactive waste and spent nuclear fuel. When such a repository is available, spent nuclear fuel would be transferred for disposal from nuclear reactor site to the repository. Until a repository is available, spent nuclear fuel is stored in the reactor pool, or in another acceptable method, such as in a dry cask storage system.

The current inventory of spent nuclear fuel at FFTF is approximately 11 metric tons of heavy metal, predominantly mixed plutonium-uranium oxide encapsulated in stainless steel. About 3 percent, (i.e., 0.3 metric tons of heavy metal) is of sodium-bonded spent nuclear fuel. In addition, there is 0.02 metric tons of heavy metal training, research, isotopes General Atomics (TRIGA) spent nuclear fuel. This constitutes less than 1 percent of the cumulative spent nuclear fuel (about 2,133 metric tons of heavy metal), including defense and nondefense fuel at Hanford. More detailed information on spent fuel storage at FFTF can be found in Appendix D.

3.5 GENERIC COMMERCIAL LIGHT WATER REACTOR SITE

Existing CLWRs use both pressurized water and boiling water technologies. Previous studies for the tritium supply program showed that, of the two types of commercial reactors, pressurized-water reactors are more readily adaptable than boiling-water reactors to the production of isotopes by target irradiation (DOE 1995b). DOE published a request for Expressions of Interest in the January 4, 1999, *Commerce Business Daily* for the production of plutonium-238 for space missions (DOE 1999n). No responses by the commercial nuclear industry to DOE's request for Expressions of Interest were provided by, or on behalf of, boiling-water reactor owners. The evaluation of CLWRs in this NI PEIS, therefore, will only be based on the use of pressurized-water reactors.

The use of CLWRs is not appropriate for the production of medical and industrial isotopes or to support civilian nuclear research and development because CLWRs operate on a 9- to 18-month cycle between refueling outages. Many medical and industrial isotopes have short half-lives and would decay before they could be removed from the reactors. In addition, CLWRs are not good irradiation sources for many civilian nuclear research tests because the range of neutron fluxes present in CLWR is limited, and the flux is optimized for power production rather than research. Accordingly, CLWRs are not appropriate irradiation sources for either medical and industrial isotope production or civilian nuclear research and development.

Because it is unreasonable for this NI PEIS to analyze all CLWRs, the environmental baseline was developed for a generic CLWR site description that is representative of existing reactor sites in the contiguous United States. The generic CLWR analysis in this NI PEIS is not site specific. Any one of the commercial, operating pressurized-water reactors is a potential candidate for the plutonium-238 production mission. Currently, 72 pressurized-water reactors are located at 42 sites in 27 states. The commercial, pressurized-water reactors operating in the United States that would be representative of the CLWR described and analyzed in this NI PEIS are shown in **Figure 3–10**. If an alternative were selected that involves the use of an existing CLWR site, site-specific environmental conditions would be identified in tiered NEPA documentation.

3.5.1 Land Resources

Land resources include land use and visual resources. Each of these resources is described below.

3.5.1.1 Land Use

Land may be characterized by its potential for the location of human activities (land use). Natural resource attributes and other environmental characteristics could make a site more suitable for some land uses than for others. Changes in land use may have both beneficial and adverse effects on other resources such as ecological, cultural, geological, aquatic, and atmospheric.

CLWR site areas within the United States range from 34 to 12,000 hectares (84 to 29,700 acres). Almost 60 percent of the plant sites encompass from 200 to 800 hectares (490 to 1,980 acres). Approximately half of the sites contain two or three nuclear units per site. Larger land use areas are associated with plant cooling systems that include reservoirs, artificial lakes, and buffer areas. Plant facilities are typically sited on 3 to 9 percent of the total site area. For sites that use cooling ponds instead of cooling towers, facilities could occupy a larger percentage, 67 to 76 percent, of the total site area (DOE 1996b).

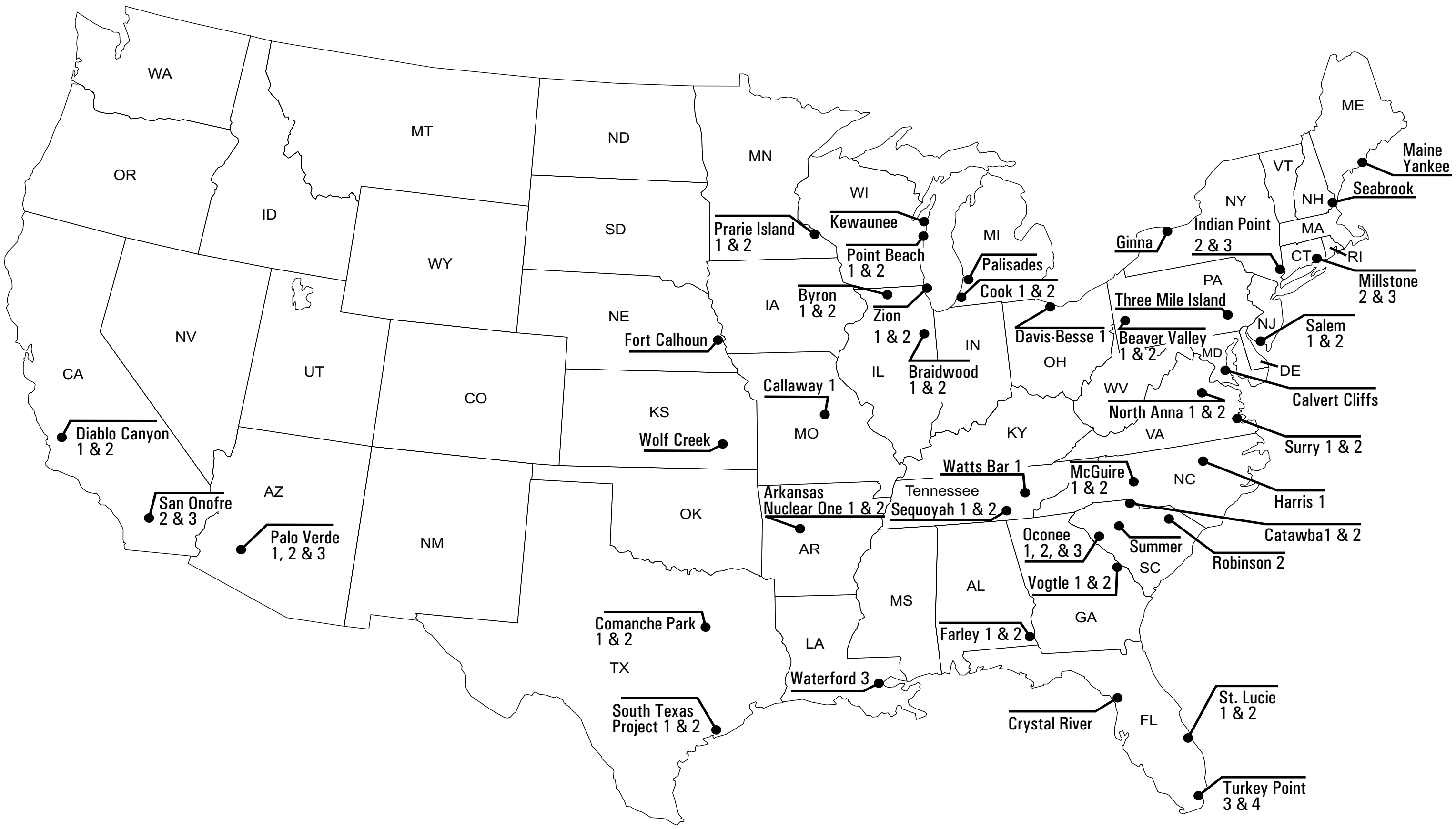

Figure 3–10 Commercial Pressurized-Water Reactors Operating in the United States

Typically, nuclear power plant sites are on and near flat-to-rolling countryside in wooded or agricultural areas. More than 50 percent of the sites have 80-kilometer (50-mile) population densities of fewer than 77 persons per square kilometer (200 persons per square mile) and more than 80 percent have 80-kilometer (50-mile) densities of fewer than 193 persons per square kilometer (500 persons per square mile) (DOE 1996b).

The location of a generic CLWR site would range between 3 and 55 kilometers (2 and 34 miles) from the nearest city, and most likely be further from the closest metropolitan area than 80 kilometers (50 miles). The site would likely be located adjacent to a large water body, such as a lake, river, or bay.

3.5.1.2 Visual Resources

Visual resources are natural and human-created features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape.

The visual environment of a generic CLWR site would likely be characterized by flat to gently rolling topography adjacent to a large water body. The site would be a developed area that contains facilities and activities, surrounded by an undeveloped buffer area. The viewshed would likely include a small-to-medium sized urbanized area with surrounding forest and agricultural use. Depending on topography, atmospheric conditions, vegetation, and distance, the facilities of a generic existing CLWR site could be visible from adjacent viewpoints. Stack plumes from cooling towers could be visible under most meteorological conditions. Median visible plume lengths would usually range from less than 500 meters (1,640 feet) in summer to 1,000 meters (3,280 feet) in winter. The facilities would be brightly lit at night. The range of public viewpoints could include public access roadways, urbanized areas, and recreation and scenic areas with high user volumes. Since the site would be adjacent to a large water body, it would be likely that distance zones would range from foreground to middleground. The developed areas of a generic existing CLWR site would likely be consistent with a Bureau of Land Management Visual Resource Management Class IV rating (DOE 1996b) indicating that the level of change to the characteristic landscape is high and that management activities dominate the view and are the major focus of view attention.

3.5.2 Noise

Principal noise sources at nuclear power plants include cooling towers and transformers. The impacts of these and other sources at the plants have been found to be small and generally not noticed by the public (NRC 1996:17). In most cases, noise sources are sufficiently distant from sensitive receptors that noise is attenuated to nearly ambient levels, although at some sites, sensitive receptors were identified during licensing at which noise levels would be greater than 10 decibels above ambient (NRC 1996:139). An area near a CLWR site would be essentially rural in character and would have typically low background sound levels. Typical day and night average sound levels in the range of 35 to 50 dBA can be expected for such a rural location where noise sources may include wind, insect activity, aircraft, and agricultural activity. Existing industrial noise sources and traffic noise at the site would result in higher background noise levels near the site and along site access routes (DOE 1996b:3-387).

3.5.3 Air Quality

Air pollution refers to the introduction, directly or indirectly, of any substance into the air that could endanger human health, harm living resources and ecosystems as well as material property, and impair or interfere with the comfortable enjoyment of life or other legitimate uses of the environment.

Ambient air quality conditions at CLWR sites in the United States could include a wide range of pollutants and conditions. The baseline air concentrations for criteria pollutants at a generic CLWR site are presented in **Table 3–29**. These concentrations are based on ambient monitoring data collected near a representative CLWR site. Some potential CLWR sites are near or within nonattainment areas for PM_{10}, ozone, and carbon monoxide. The maximum ground-level pollutant concentrations that would result from CLWR emissions are low when compared to AAQS. However, if the CLWR is in an area that may already have high background pollutant concentrations, resultant pollutant concentrations could approach or exceed AAQS. As a result, regulatory compliance will need to be assesed on a case-by-case basis.

Table 3–29 Comparison of Baseline Air Concentrations with Most Stringent Applicable Regulations or Guidelines at the Generic CLWR Site

Criteria Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (micrograms per cubic meter)	Baseline Concentration (micrograms per cubic meter)
Carbon monoxide	8 hours	10,000	1,250
	1 hour	40,000	1,250
Lead	Calendar quarter	1.5	0.03
Nitrogen dioxide	Annual	100	26.3
Ozone	1 hour	235	(b)
PM_{10}	Annual	50	20.3
	24 hours	150	39.000
Sulfur dioxide	Annual	80	10.5
	24 hours	365	65.5
	3 hours	1300	204

a. The Federal standards are presented.
b. Ozone, as a criteria pollutant, is not directly emitted or monitored by the sites.
Key: PM_{10}, particulate matter with an aerodynamic diameter less than or equal to 10 microns.
Source: DOE 1999o.

3.5.4 Water Resources

Major surface water features near a generic CLWR site could range from a large navigable river to a large lake. These surface waters would be classified and protected by regulation for specified uses, such as water supply. CLWRs would also have NPDES permits that specify the concentrations of pollutants and temperature permissible for liquid effluents and stormwater runoff discharged to surface waters. Other surface water bodies could include ponds and/or site-bordering ephemeral or perennial streams (DOE 1996b:3-388).

CLWRs withdraw large amounts of mainly surface water to meet a variety of plant needs. Water withdrawal rates from adjacent bodies of water for plants with once-through cooling systems are large. Flow through the condenser for a 1,000 megawatt plant may be 2.6 million to 3.8 million liters (700,000 to 1 million gallons) per minute. Water lost by evaporation from the heated discharge is about 60 percent of that which is lost through cooling towers. Additional water needs for service water, auxiliary systems, and radioactive waste systems account for 1 to 15 percent of that needed for condenser cooling (DOE 1995b:4-510).

Water withdrawal from adjacent bodies of water for plants with closed-cycle cooling systems is 5 to 10 percent of that with once-through cooling systems, with much of this water being used for makeup of water by evaporation. With once-through cooling systems, evaporative losses are about 40 percent less but occur externally in the adjacent body of water instead of in the closed-cycle system. The average makeup water withdrawals for several of the more recently constructed plants having closed-cycle cooling, normalized to

1,000 megawatts, are about 53,000 to 68,000 liters (14,000 to 18,000 gallons) per minute. Variation is due to cooling tower design, concentration factor of recirculated water, climate at the site, plant operating conditions, and other plant-specific factors. Consumptive loss normalized to 1,000 megawatts is about 42,400 liters (11,200 gallons) per minute, which is about 80 percent of the water volume taken in (DOE 1995b:4-510).

These consumptive water losses remove surface water from other uses downstream. In those areas experiencing water availability problems, nuclear power plant consumption may conflict with other existing or potential closed-cycle uses (e.g., municipal and agricultural water withdrawals) and in-stream uses (e.g., adequate in-stream flows to protect aquatic biota, recreation, and riparian communities) (DOE 1995b:4-510).

Some CLWRs use groundwater as an additional source of water. The rate of usage varies greatly among users. Many plants use groundwater only for the potable water system and require less than 380 liters (100 gallons) per minute; however, withdrawals at other sites can range from 1,500 to 11,000 liters (400 to 3,000 gallons) per minute (DOE 1995b:4-510).

3.5.5 Geology and Soils

The physiography of a CLWR site could range from a flat nearly featureless plain to a highly dissected plain of arid to humid environments. The geology could range from alluvium to thick sequences of unconsolidated marine sediments, glaciofluvial material, and crystalline and sedimentary bedrock. These materials could range in age from Cenozoic to Precambrian (recent to over 600 million years) (DOE 1996b:3-389).

The generic CLWR site could be located in regions that may have a low to moderate seismic risk as a result of an earthquake based on historical seismic activity. The location of the nearest capable fault could range from within the site boundaries to 350 kilometers (217 miles) away from CLWR sites. The nearest known epicenter of a damaging earthquake could be approximately 350 kilometers (217 miles) from existing CLWR sites (DOE 1996b:3-389).

The CLWR sites are not within a region of active volcanism; however, a generic CLWR site could be within 164 kilometers (102 miles) of a volcano (DOE 1996b:3-389).

The CLWR sites could be located where the predominant soil types are loamy clays to gravel silty loams. These soils range from moderate to well drained soils. The erosion potential could range from minor to severe in those areas with slopes greater than 25 percent and which have been eroded in the past. Shrink-swell potential could range from low to severe, which is acceptable for standard construction techniques, depending upon the engineering controls employed. Wind erosion potential ranges from minor to severe (DOE 1996b:3-389).

3.5.6 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. The nature of these resources in the vicinity of a CLWR is highly dependent upon the specific location of an existing reactor. All CLWR sites were developed within the requirements of applicable Federal and state natural resource laws and regulations.

3.5.6.1 Terrestrial Resources

Terrestrial resources in the vicinity of a generic CLWR site would include those plant and animal communities typical of the ecoregion within which the facility is located. Ecoregions are characterized by distinctive flora, fauna, climate, landform, soil, vegetation, and ecological climax (Bailey 1976). Within such a region, ecological relationships between plant species, and soil and climate are essentially similar. Provinces are subdivisions that are a broad vegetation region with the same type or types of zonal soils. Provinces within which a CLWR could be located may include, but are not limited to the eastern deciduous forest; southeastern mixed forest; outer coastal plain forest; prairie parkland; Great Plains short-grass prairie; tall-grass prairie; American desert; and California chaparral. These provinces are further subdivided by Bailey (1976) based on specific climax vegetation.

3.5.6.2 Wetlands

Since the need for cooling water is an important operational requirement, most CLWRs are constructed near rivers, lakes, reservoirs, or oceans. In each case, the presence of wetlands in the vicinity of the faciltiy may be expected. Major types of wetlands, which could occur near a generic CLWR, include tidal salt marshes, freshwater marshes, northern peatlands, shrub swamps, and forested wetlands. Wetlands serve a variety of important functions including maintaining water quality, controlling floodwaters, stabilizing shorelines, and providing recreational uses such as hunting and fishing. Wetlands are also important in providing habitat for terrestrial and aquatic organisms including migratory birds and threatened and endangered plants and animals.

3.5.6.3 Aquatic Resources

Nearly all CLWRs are constructed near a source of cooling water such as a river, lake, reservoir, or ocean. The abiotic and biotic characteristics of each type of water body vary with its geographic location.

3.5.6.4 Threatened and Endangered Species

Threatened and endangered species could be present in each of the ecoregions within which a generic CLWR could be located. At present, there are 1,230 federally listed threatened and endangered species in the United States (FWS 2000). States also typically identify threatened and endangered, as well as other special status species, found within their borders. Endangered plants and animals often rely on sensitive environments, such as wetlands, for habitat. Critical habitats, areas that are considered essential to the conservation of a species and that could require special management considerations or protection, can be designated and protected under the *Endangered Species Act*. Protection of threatened and endangered species and their habitat is important for maintaining biodiversity.

3.5.7 Cultural and Paleontological Resources

Cultural and paleontological resources include prehistoric resources, historic resources, Native American resources, and paleontological resources. The presence or absence of such resources is highly dependent upon the location of a specific existing CLWR. In accordance with applicable Federal and state laws and regulations, all existing sites would have been surveyed for such resources prior to site construction. Further, consultation with the State Historic Preservation Officer and tribal governments would have been required.

3.5.7.1 Prehistoric Resources

Prehistoric resources in the vicinity of the generic CLWR may include sites, districts, or isolated artifacts. Archaeological sites may represent occupation during the Archaic through later prehistoric periods and can include hunting and butchering sites, cemeteries, campsites, and tool manufacturing areas. They may yield artifacts such as stone tools and associated manufacturing debris, and ceramic potsherds. Some sites may be included on the National Register of Historic Places, while others may be eligible for listing.

3.5.7.2 Historic Resources

Historic resources may include cemeteries, remains of commercial or residential structures, or standing structures. While some sites may already be listed on the National Register of Historic Places, others may be eligible for listing.

3.5.7.3 Native American Resources

Native American resources can include cemeteries, geological or geographic elements such as mountains or creeks, certain species of animals or plants, architectural structures, such as pueblos; battlefields, or trails. Such resources are important to Native American groups for religious or historical reasons.

3.5.7.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. Paleontological remains consist of fossils and their associated geological information. The presence of such resources at a generic CLWR site is dependent upon the past geologic history of the site.

3.5.8 Socioeconomics

The CLWR site could potentially affect the socioeconomic environment of a given regional economic area or region of influence. The characteristics of the regional economic area, region of influence, and community are dependent upon geographic location. For employment and income, the economic area would be based upon industry interaction and linkages in the region. The anticipated residential distribution of project-related employees and their families would determine the region of influence. This region of influence would contain all principal jurisdictions and school districts likely to be affected by the proposed activity.

Socioeconomic characteristics described for the generic CLWR site include employment and local economy, population and housing, and local transportation. Four hypothetical sites (A, B, C, and D) have been developed for the generic CLWR for purposes of making these characterizations. Site A, which had a nearby 1992 population of 2,604, was located about 160 kilometers (100 miles) from a large metropolitan area. Site B, with a nearby 1992 population of 5,236, was located approximately 8 kilometers (5 miles) from a small community and approximately 64 kilometers (40 miles) from a large metropolitan area. Site C, with a nearby 1992 population of 44,384, was located approximately 16 kilometers (10 miles) from a medium-size community and approximately 48 kilometers (30 miles) from a large metropolitan area. Site D, with a nearby 1992 population of 34,201 and a total urban population of more than 100,000. Statistics for employment and local economy were based on the regional economic area for each site. Statistics for the remaining socioeconomic characteristics were based on the sites' regions of influence (DOE 1996b).

3.5.8.1 Regional Economic Characteristics

Employment and regional economy statistics for each representative site's regional economic area are discussed in this section. Between 1980 and 1990, the civilian labor force in the region of economic area encompassing Site A increased 7.7 percent to the 1990 level of 4,811,800, and for Site B increased 49.6 percent to the 1990 level of 1,162,300. The civilian labor force for Site C, located near a large metropolitan area, increased 21.9 percent to the 1990 level of 862,500. The civilian labor force for Site D, located in an urbanized area, increased 9.9 percent to 254,800 persons. The 1994 unemployment rates in the two small communities' (A and B) regional economic areas were 5.6 percent and 5.2 percent, respectively. Sites C and D had unemployment of 4.3 percent and 9.1 percent, respectively.

For the two small representative communities, the portions of total employment involving farming in the regional economic areas were about 1 percent. Governmental activities for Sites A and B represented about 12 percent and 14 percent, respectively. Manufacturing was 16 percent of the total employment for site A and 10 percent for site B. Retail trade accounted for 16 percent and 18 percent of the total sector employment for Sites A and B, respectively. Service activities represented a 30 percent share of the total employment for Sites A and B.

For Sites C and D, the portion of total employment was about 1 percent and 12 percent for farming and 11 and 15 percent for governmental activities, respectively. The nonfarm private sector activities of retail trade and services were 16 and 22 percent of total employment, respectively, for Site C and 16 and 26 percent, respectively, for Site D. Employments for manufacturing were 23 and 8 percent of total employment for Sites C and D, respectively (DOE 1996b).

3.5.8.2 Population and Housing

Between 1980 and 1994 the region of influence population increase for the two small communities, A and B, was 6.4 percent (average annual increase of 0.5 percent) and 54.6 percent (average annual increase of 3.9 percent), respectively. The number of housing units in the region of influence increased 8.9 percent for Site A and 55.8 percent for Site B between 1980 and 1990. The 1990 region of influence homeowner vacancy rates were 1.1 and 3.9 percent, while the renter vacancy rates were 5.9 and 16.4 percent for Sites A and B, respectively.

The regions of influence surrounding Sites C and D experienced an 31.8 percent (average annual increase of 2.3 percent) and 19.8 percent (average annual increase of 1.4 percent) increase in population, between 1980 and 1994, and a 32.7 an 5.4 percent increase, respectively, in the number of housing units between 1980 and 1990.

The 1990 homeowner and renter vacancy rates were 2.0 and 8.9 percent for Site C and 1.3 and 5.6 percent for Site D (DOE 1996b).

3.5.8.3 Community Services and Local Transportation

These characteristics are dependent upon geographic location. The region of influence would determine all principal jurisdictions and school districts likely to be affected by the proposed activity. Local transportation would be the existing principal road, air, and rail networks required to support the project activities (DOE 1996b).

3.5.9 Existing Human Health Risk

3.5.9.1 Radiation Exposure and Risk

Major sources and levels of background radiation exposure to individuals in the vicinity of the CLWR site are shown on **Table 3–30.** Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population size changes as the population size changes. Background radiation doses are unrelated to CLWR site operations.

Table 3–30 Sources of Radiation Exposure to Individuals in the Vicinity Unrelated to Operation at the CLWR Site

Source	Effective Dose Equivalent (millirem per year)
Natural background radiation	
Cosmic radiation	27 to 29
Cosmogenic radiation	1
External terrestrial radiation	29 to 30
Radon in homes (inhaled)	200
Internal terrestrial radiation	39
Other background radiation	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	Less than 1
Air travel	1
Consumer and industrial products	10
Total	361 to 364

Note: Value of radon is an average for the United States.
Source: DOE 1996b.

Releases of radionuclides to the environment from CLWR site operations provide another source of radiation exposure to individuals in the vicinity of CLWR sites. Types and quantities of radionuclides released from CLWR site operations are listed in the annual radiological effluent release reports for the reference sites. The doses to the public resulting from these releases are presented in **Table 3–31.** These doses fall within radiological guidelines and limits (10 CFR Part 50, Appendix I, and 40 CFR Part 190) and are small (less than 0.01 percent) in comparison to background radiation.

Table 3–31 Radiation Doses to the Public from Normal Operation in 1994 at the Generic Existing CLWR Site (Committed Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual[b]**
Maximally exposed individual (millirem)	5	0.0013 to 1.10	3 per reactor	0 to 0.29	25	0.0078 to 1.39
Population within 80 kilometers[c] (person-rem)	None	0.016 to 13.3	None	0 to 1.28	None	0.020 to 13.3
Average individual within 80 kilometers [d] (millirem)	None	6.3×10^{-5} to 6.8×10^{-3}	None	0 to 8×10^{-4}	None	7.9×10^{-5} to 6.8×10^{-3}

a. The standards for individuals are given in 10 CFR Part 50, Appendix I, and 40 CFR Part 190. As discussed in Appendix I of 10 CFR Part 50, the 5-millirem-per-year value is an airborne emission guideline, and the 3-millirem-per-year per reactor value is a liquid release guideline. Meeting these guideline values serves as a numerical demonstration that doses are as low as is reasonably achievable. The total dose of 25 millirem per year is the limit from all pathways combined as given in 40 CFR Part 190.
b. Totals cannot be obtained by summing the atmospheric and liquid release components since these component entries can be for different reactor sites.
c. This population ranges from 252,000 to 1,960,000.
d. Obtained by dividing the population dose by the number of people living within 80 kilometers (50 miles) of the site.

Source: DOE 1996b:3-398.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public, the latent cancer fatality risk to the maximally exposed member of the public due to radiological releases from operations at the CLWR site is estimated to range from 3.9×10^{-9} to 7.0×10^{-7} per year. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of CLWR site operation ranges from about 4 in 1 billion to 7 in 10 million. Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.

Based on the same risk estimator, a range of 1.0×10^{-5} to 6.7×10^{-3} excess fatal cancers is projected in the population living within 80 kilometers (50 miles) of the CLWR site from normal operations. To place these numbers into perspective, they can be compared with the numbers of fatal cancers expected in these populations from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year. Based on this mortality rate, the number of fatal cancers expected from all causes in the population living within 80 kilometers (50 miles) of the CLWR site ranged from 505 to 3,920. These numbers of expected fatal cancers are much higher than the estimated range of 1.0×10^{-5} to 6.7×10^{-3} fatal cancers that could result from operations at the CLWR site.

At the CLWR site, workers receive the same dose as the general public from background radiation but also receive an additional dose from working at the site. The range of the average worker, maximally exposed worker, and total worker dose from operations at the generic existing CLWR site are presented in **Table 3–32**. These doses fall within radiological regulatory limits (10 CFR Part 20). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers, the number of excess fatal cancers to CLWR site workers from operations is estimated to range from 0.16 to 0.34 per year (DOE 1996b).

Table 3–32 Annual Doses to Workers from Normal Operation at the Generic CLWR Site (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (millirem)	ALARA[b]	114 to 322
Total workers[c] (person-rem)	ALARA	396 to 854

a. NRC's goal is to maintain radiological exposures as low as is reasonably achievable.
b. As low as is reasonably achievable.
c. The number of badged workers ranges from 2,650 to 4,370.
Source: DOE 1996b:3-399.

3.5.9.2 Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., surface waters during swimming and soil through direct contact or via the food pathway).

Carcinogenic Effects. Health effects in this case are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. This could be incremental or excess individual lifetime cancer risks.

Noncarcinogenic Effects. Health effects in this case are determined by the ratio between the calculated or measured concentration of the chemical in the air and the reference concentration or dose. This ratio is known as the Hazard Quotient. Hazard Quotients for noncarcingoens are summed to obtain the Hazard Index. If the Hazard Index is less than 1, no adverse health effects would be expected.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements, for example, air emissions and NPDES permit requirements contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at CLWR sites via inhalation of air containing hazardous chemicals released to the atmosphere by site operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Exposure pathways for CLWR site workers during normal operation may include inhaling the workplace atmosphere and direct contact with hazardous material associated with work assignments. Occupational exposure varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. At the CLWR site, workers are also protected by adherence to OSHA and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals used in the operational processes ensures that these standards are not exceeded (DOE 1996b).

3.5.9.3 Health Effects Studies

CLWRs have been operating for many years. Site-specific epidemiological studies may be available, and these studies would be reviewed for specific CLWR locations. Epidemiologic studies will be considered in the future.

3.5.9.4 Accident History

CLWRs have been operating in the United States for many years. Accident information for these reactors, where applicable, can be found in documentation available from NRC.

3.5.9.5 Emergency Preparedness

The CLWR site would have an NRC-approved emergency management program that would be activated in the event of an accident. The programs are compatible with other Federal, state, and local plans and are thoroughly coordinated with all interested groups.

3.5.10 Environmental Justice

As discussed in Appendix K, Executive Order 12898 directs Federal agencies to address disproportionately high and adverse health or environmental effects of alternatives on minority and low-income populations. The Executive order does not alter prevailing statutory interpretations under NEPA or existing case law. Regulations prepared by the Council on Environmental Quality remain the foundation for preparing environmental documentation in compliance with NEPA (40 CFR Parts 1500 through 1508) and the Council's guidelines for inclusion of environmental justice under NEPA (CEQ 1997). As the present document is a programmatic EIS, environmental justice issues would be addressed in a site-specific EIS if an option using a CLWR were to be selected.

3.5.11 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing CLWR activities. The waste is managed using appropriate treatment, storage, and disposal technologies, and in compliance with all NRC and other applicable governmental regulations.

3.5.11.1 Waste Inventories and Activities

The amounts of waste generated are reported on a quarterly basis by each nuclear utility. The waste volumes of CLWRs are given in **Table 3–33**. These volumes are based on site-specific data (DOE 1996b and DOE 1999o). Because high-level radioactive waste would not be generated by neptunium-237 target irradiation activities at the generic CLWR site, it is not included in this table or discussed any further in this section.

Table 3–33 Existing Pressurized-Light Water Reactor Site Waste Management Characteristics

Characteristic	Range	Average
Low-level radioactive waste shipped (cubic meters per year)	57.04 to 636.85	178.22
Number of low-level radioactive waste shipments per year	6.00 to 31.00	16.17
Stored mixed low-level radioactive waste per 1,000 megawatt (cubic meters per year)	Not reported	101.90[a]
Hazardous waste generation (cubic meters per year)	11.4 to 29	23
Nonhazardous waste generation (cubic meters per year)		
Liquids	682 to 60,794	37,072
Solids	909 to 10,400	4,148

a. This is the average of both pressurized-water reactors and boiling-water reactors. A value was not specifically reported for the pressurized-water reactor category.

Note: To convert from cubic meters to cubic yards, multiply by 1.308.

Source: DOE 1996b:3-401 for low-level radioactive waste and mixed low-level radioactive waste; DOE 1999o:chap. 3 for hazardous and nonhazardous waste.

Waste management and activities specific to each category of waste are discussed in the following sections.

3.5.11.2 Transuranic Waste

Transuranic elements are contained within spent nuclear fuel. Transuranic waste is not generated or managed at CLWR sites.

3.5.11.3 Low-Level Radioactive Waste

Liquid low-level radioactive waste generated in CLWRs could be classified as either clean waste, dirty waste, turbine building floor drain water, or steam generator blowdown. Clean wastes come from equipment leaks and drains, certain valve and pump seal leakoffs not collected in the reactor coolant drain tank, and other aerated leakage sources. Primary coolant is also considered a clean waste. Liquid wastes collected in the containment building sump, auxiliary building sumps and drains, laboratory drains, sample station drains, and other miscellaneous floor drains are termed dirty wastes because of their moderate conductivity. Clean and dirty wastes will have variable radioactivity content. Detergent wastes, which consist of laundry wastes and personnel and equipment decontamination wastes, normally have a low radioactivity content. Turbine building floor drain water usually exhibits high conductivity with low radionuclide content. Depending on the amount of primary-to-secondary leakage, steam generator blowdown could have relatively high concentrations of radionuclides. The chemical and radionuclide content of the waste would determine the type and degree of treatment before storage for reuse or discharge to the environment. Operating plants have steadily increased the degree of processing, storing, and recycling of liquid radioactive waste (DOE 1996b:3-402).

Solid low-level radioactive waste is generated by removal of radionuclides from liquid waste streams, filtration of airborne gaseous emissions, and removal of contaminated material from various reactor areas. Liquid contaminated with radionuclides comes from primary and secondary coolant systems, spent-fuel pools, decontaminated wastewater, and laboratory operations. Concentrated liquids, filter sludges, waste oils, and other liquid sources are segregated by type, flushed to storage tanks, stabilized for packaging in a solid form by dewatering, and slurried into 208-liter (55-gallon) steel drums prior to disposal. High efficiency particulate air filters are used to remove radioactive material from gaseous plant effluents. These filters are compacted and disposed of as solid low-level radioactive waste. Other solid low-level radioactive waste includes contaminated protective clothing, paper, rags, glassware, compactible and noncompactible trash, and nonfuel irradiated reactor components and equipment. Tools and other material exposed to the reactor environment would also be considered solid low-level radioactive waste. Compactible solid low-level radioactive waste is taken to an offsite or onsite volume reduction facility before disposal. Solid low-level radioactive waste is stored in shielded prefabricated steel buildings or other facilities until suitable for disposal at an approved low-level radioactive waste disposal facility (DOE 1996b:3-402).

3.5.11.4 Mixed Low-Level Radioactive Waste

Mixed low-level radioactive waste generated by a nuclear power plant covers a broad spectrum of waste types. The vast majority of mixed waste in storage at nuclear plants is chlorinated fluorocarbons and waste oil. Mixed low-level radioactive waste is stored on site until treatment and disposal is available at an offsite RCRA-permitted facility. Because of the occupational exposure from testing radioactive wastes to determine if they are chemically hazardous, the utilities have been looking at ways to eliminate, or at least minimize, the generation of mixed wastes. These efforts include removing and separating hazardous constituents from radioactive streams by remote methods; minimizing the use of solvents exposed to the reactor environment; relying on substitute processes; and recycling and reusing cleaning materials, resins, and waste oils (DOE 1996b). Stored mixed low-level radioactive waste per 1,000 megawatt averages about 100 cubic meters (130 cubic yards) per year for the existing plants studied.

3.5.11.5 Hazardous Waste

Hazardous wastes are generated from nonradioactive materials such as wipes contaminated with oils, lubricants, and cleaning solvents that are used outside the reactor environment. Hazardous wastes are packaged and shipped to offsite RCRA-permitted treatment and disposal facilities.

3.5.11.6 Nonhazardous Waste

Nonhazardous wastes include boiler blowdown, water treatment wastes, boiler metal cleaning wastes, floor and yard drain wastes, storm water runoff, and sewage wastes. Depending on the design of the individual reactor, other small volumes of wastewater are released from other plant systems or combined with the cooling water discharges. Sanitary wastes that cannot be processed by onsite waste treatment systems are collected by independent contractors and trucked to offsite treatment facilities (DOE 1996b:3-402).

3.5.11.7 Waste Minimization

Because of the increased disposal costs for low-level radioactive waste, utility companies have undertaken major volume reduction and waste minimization efforts. These efforts include segregation, decontamination, minimizing the exposure of materials and tools to the contaminated environment, and sorting. Compacting, consolidating, and monitoring waste streams to reduce the volume of low-level radioactive waste requiring storage, and lessening the exposure of routine equipment to the reactor environment, have been the most effective volume reduction strategies. Current industry-wide volume reduction practices include ultra-high pressure compaction of waste drums, incineration of waste oils and resins, mobile thin-film evaporation, waste crystallization, and asphalt solidification of resins and sludges (DOE 1996b:3-400).

Nuclear power plants typically have waste minimization programs in place to minimize both the volume and cost impact of waste generation. In existing operating plants, a number of the design considerations that affect the plant waste streams are already in place, and improvements in waste management are continually being implemented. Waste minimization steps include more economical use of disposables or elimination of disposables in favor of recyclables. Process improvements aimed at more efficient use of ion exchange resins and reductions of waste streams from the waste processes are being implemented. In general, wastes generated by operating plants have been decreasing in recent years.

3.6 DOE Site for New Accelerator(s) or a New Research Reactor

Under Alternative 3, DOE would construct one or two new accelerators for medical and industrial production, plutonium-238 production, and civilian nuclear research and development. In addition, DOE would construct a support facility for the processing of medical and industrial isotopes and for processing associated with research and development activities. Under Alternative 4, DOE would construct a new research reactor and support facility for this same purpose. Processing activities associated with plutonium-238 production would be performed at an existing DOE facility. The new accelerator(s), research reactor, and support facility would be located at an existing DOE site. No DOE site has been identified as the location of these facilities. If DOE were to select these alternatives, a follow-on EIS would be required to select the specific DOE site where the new accelerator(s), research reactor, and support facility would be located. In that document, DOE would identify site-specific environmental conditions, as well as evaluate the environmental impacts of facility construction and operation on the DOE sites being considered.

Because it is unreasonable for this NI PEIS to analyze all DOE sites, the environmental baseline was developed for a generic DOE site description that is representative of existing DOE sites. The generic DOE analysis does not include a specific DOE site for analysis in this NI PEIS. Any existing DOE site is a potential candidate for the new accelerator(s) or research reactor to support DOE's civilian missions for nuclear research and development and isotope production. One factor that would be considered in identifying candidate DOE sites would be the availability of existing facilities and infrastructure at the sites for support of the accelerator(s), research reactor, and support facility.

3.6.1 Land Resources

Land resources include land use and visual resources. Each of these resource areas is described for the site as a whole, as well as for the proposed facility locations.

3.6.1.1 Land Use

Land may be characterized by its potential for the location of human activities (land use). Natural resource attributes and other environmental characteristics could make a site more suitable for some land uses than for others. Changes in land use may have both beneficial and adverse effects on other resources such as ecological, cultural, geological, aquatic, and atmospheric.

DOE sites range from 165 hectares (408 acres) to 350,000 hectares (865,000 acres) in size. While these sites were established for a variety of reasons including nuclear weapons research, development, production, and testing, and energy research and development, the extent of development within each site varies greatly. Facilities located within smaller sites typically occupy a greater percentage of the site than on the larger sites, where from 1 to 25 percent of the site is developed. Undeveloped portions of the sites are used as buffers and in many cases represent land that has remained largely undisturbed since it first came under the jurisdiction of the Federal government. Depending upon the site, undeveloped land may be used for forestry, grazing, wildlife management, or for ecological research. For, example, a number of the sites have areas designated as National Environmental Research Parks within their borders. These areas are devoted to research by the nation's scientific community on the impact of human activities on the natural environment. Land uses bordering DOE sites varies from developed urban areas to open spaces in which forestry, wildlife management, farming, grazing, and other rural land uses predominate. Many sites have developed land use plans and recently some have released land for redevelopment by the private sector.

3.6.1.2 Visual Resources

Visual resources are natural and human-created features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape.

The visual environment of DOE sites is extremely varied. Certain sites are more highly developed and located near urban areas, while others are only sparsely developed and located many miles from human settlement. Smaller sites and developed portions of larger sites would have a Bureau of Management Visual Resource Management Class IV rating, indicating that the level of change to the characteristic landscape is high and that management activities dominate the view and are the major focus of viewer attention. The Visual Resource Management rating of undeveloped portions of larger DOE sites may range from Class II to Class III. In general, these ratings are characteristic of a less developed landscape and, although management activities may be seen, they should not attract the attention of the casual observer or dominate the view. Views of developed portions of sites located within the eastern United States are often limited due to screening by vegetation and terrain. In the western Unites States vegetation is generally more sparse and in many case the landscape is relatively flat. Thus, developed portions of these sites are typically visible from greater distances. Sites located near urban areas are viewed by more people than are the more isolated sites.

3.6.2 Noise

Existing noise sources and characteristics at a DOE site where the new accelerator(s), research reactor, and support facility might be sited can be expected to be similar to existing DOE sites and are generally described as follows. Major noise emission sources include various industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, construction and materials-handling equipment, and vehicles). Most industrial facilities are a sufficient distance from the site boundary that noise levels at the boundary from these sources are not measurable, or are barely distinguishable from background noise levels.

Existing site-related noises of public significance would be from the transportation of people and materials to and from site. Noise measurements taken near the site would likely indicate that noise levels are consistent with nearby land uses which are primarily rural. Noise levels along roads and access routes to the site would be higher and may result in some annoyance at residences and other noise sensitive land uses near the roads, especially during peak traffic hours.

3.6.3 Air Quality

Ambient air quality at a generic DOE site would be expected to be in compliance with the NAAQS and with the state ambient air quality regulations. A range of ambient air concentrations for criteria pollutants representative of existing DOE sites are presented in **Table 3–34**.

Existing nonradiological air pollutant sources and characteristics at a DOE site where the new accelerator(s), research reactor, and support facility might be sited can be expected to be similar to existing DOE sites. The primary sources of criteria air pollutants could include steam and power generation facilities, incinerators, waste processing sources, various other process sources, vehicles, temporary emissions from construction activities, and fugitive dust from coal piles, construction activities, and waste disposal operations.

Table 3–34 Comparison of Baseline Ambient Air Concentrations with NAAQS at a Generic DOE Site

Pollutant	Averaging Time	NAAQS (micrograms per cubic meter)[a]	Baseline Concentration Range (micrograms per cubic meter)
Criteria pollutants			
Carbon monoxide	8 hours 1 hour	10,000 40,000	5 to 284 11 to 614
Lead	Calendar quarter	1.5	0.05
Nitrogen dioxide	Annual	100	3 to 4
Ozone	1 hour	235	(b)
PM_{10}	Annual 24 hours	50 150	1 to 3 2 to 33
Sulfur dioxide	Annual 24 hours 3 hours	80 365 1,300	2 to 6 32 to 135 80 to 579

a. NAAQS (40 CFR Part 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic PM_{10} mean standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

b. Not directly emitted or monitored by the site.

Note: EPA revised the ambient air quality standards for particulate matter and ozone in 1997; however, these standards are currently under litigation. In 1999 new standards effective in September 16, 1997 could not be enforced. The ozone standard is a 1-hour concentration of 235 micrograms per cubic meter (0.12 parts per million) (62 FR 38856). The 8-hour standard for PM_{10} could not be enforced. The current PM_{10} annual standard is retained (62 FR 38652).

Source: DOE 1996b:3-193; DOE 1999e; 40 CFR Part 50.

3.6.4 Water Resources

Major surface water features in the vicinity of a generic DOE site could range from seasonally ephemeral (intermittent) streams to perennial streams and rivers more characteristic of an eastern site. These surface waters would be classified and protected by regulation for specified uses (e.g., water supply, agriculture, fish and wildlife uses, recreation). Existing facilities would have NPDES permits that specify the concentrations of pollutants for liquid effluents and stormwater runoff discharged to surface waters. However, some surface waters could have been impacted from historic waste management activities. Process and sanitary effluents from existing facilities would be managed by wastewater treatment plants and/or by seepage or evaporation ponds. Routine and compliance monitoring of discharges would be conducted with results reported in annual site environmental reports. Some generic DOE site locations could potentially be affected by flooding (DOE 1996b:3-115, 3-194–3-196).

Groundwater could occur in aquifers comprised of strata ranging from interbedded volcanic rocks and sediments to sedimentary rocks consisting of limestone, sandstone, siltstone, and shale. Classifications of major aquifers range from Class I to Class II. Groundwater could also occur as perched groundwater. Depth to groundwater could average from about 60 to 300 meters (200 to 1,000 feet) at a western generic DOE site to about 5 to 9 meters (16 to 30 feet) beneath eastern sites. Portions of some aquifer systems, and perched groundwater tables, could have been impacted by radiological and nonradiological contaminants. Like surface waters, routine monitoring of groundwater would be conducted with results reported in annual site environmental reports (DOE 1996b:3-115–3-117, 3-196–3-199).

Water supply for a generic DOE site could be obtained from either surface water or groundwater sources (DOE 1996b:3-115, 3-194).

3.6.5 Geology and Soils

The physiography of a generic DOE site could range from the high, flat to rolling plateaus and plains underlain by nearly horizontal rock strata of the western physiographic provinces to the alternating valleys and ridges comprised of weakly to strongly folded strata of the eastern Valley and Ridge physiographic province. Surficial geology could range from relatively young (Miocene to Holocene) strata consisting of interlayered volcanic rocks (basalt, rhyolite) and unconsolidated sediments to the older (Cambrian to Ordovician), consolidated sedimentary rocks (limestone, sandstone, shale) of the eastern valleys and ridges (DOE 1996b:3-121–3-123, 3-200; DOE 1999e:3-69, 3-70).

The generic DOE site could be located in regions that may have a low to moderate seismic risk as a result of an earthquake based on historical seismic activity. The location of the nearest capable fault could range from about 19 kilometers (12 miles) to more than 480 kilometers (298 miles) (DOE 1996b:3-200; DOE 1999e:3-70, 3-71). The nearest known center of a potentially damaging earthquake to an accelerator or research reactor at a generic DOE site could range from less than 10 kilometers (6 miles) to more than 100 kilometers (62 miles) away (DOE 1996b:3-200; DOE 1999e:3-70, 3-71). New seismic hazard maps have been developed as part of the National Seismic Hazard Mapping Project which have been adapted for use in the new *International Building Code* (ICC 2000) (Figures 1615(1) and 1615(2) in the code) (Section 3.2.5.1). These maps depict maximum considered earthquake ground motion of 0.2 and 1.0 second spectral response acceleration, respectively, based on a 2 percent probability of exceedance in 50 years. Based on these maps, a generic DOE accelerator(s) or reactor site could be located anywhere within the 0.35 to 0.60 g mapping contours for a 0.2-second spectral response acceleration and the 0.10 to 0.15 g contours for a 1.0-second spectral response acceleration.

Future risks of volcanic activity affecting a generic site range from a low risk in the west to no risk in the east, with the closest volcanic features occurring 20 kilometers (12 miles) away from a DOE site (DOE 1996b:3-200; DOE 1999e:3-71).

Soil types could range from sands to loams and clays with depths ranging from shallow to deep. The soils developed from materials ranging from volcanic to sedimentary rocks including limestone, sandstone, shale, and siltstone. The soils are largely well drained. Shrink-swell potential generally ranges from low to moderate. In general, most soils are acceptable for standard construction techniques (Barghusen and Feit 1995:2.3-20, 2.8-14, 2.8-15; DOE 1996b:3-123, 3-200).

3.6.6 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. The nature of these resources in the vicinity of a generic DOE site is highly dependent upon site location. Therefore, the following discussion addresses only the broad ecological characteristics of the regions within which potential DOE sites fall. If the new accelerator(s) or research reactor alternative were selected, site-specific details would be addressed in NEPA documentation tiered to this NI PEIS.

3.6.6.1 Terrestrial Resources

Terrestrial resources in the vicinity of a generic DOE site would include those plant and animal communities typical of the ecoregion within which the facility is located. Ecoregions are characterized by distinctive flora, fauna, climate, landform, soil, vegetation, and ecological climax (Bailey 1976). Within such a region, ecological relationships between plant species, and soil and climate are essentially similar. Provinces are subdivisions that are a broad vegetation region with the same type or types of zonal soils. DOE sites are located in a broad range of provinces, including, but not limited to: Eastern deciduous forest, Southeastern mixed forest, Great plains short-grass prairie, Rocky Mountain forest, Colorado plateau, and Intermountain sagebrush. These provinces are further subdivided by Bailey (1976), based on specific climax vegetation.

3.6.6.2 Wetlands

The presence of wetlands on DOE sites vary, depending upon whether the site is located in the eastern United States where rainfall is plentiful or the western part of the country where it is sparse. Wetlands are common at eastern sites and generally uncommon at western locations. Major types of wetlands which could occur at a generic DOE site include freshwater marshes, shrub swamps, and wooded swamps. Wetlands may be either permanent or intermittent depending upon local rainfall and soil conditions. The existence of manmade wetlands associated with some sites is dependent on continued site operations. Wetlands serve a variety of important functions including maintaining water quality, controlling floodwaters, stabilizing shorelines, and providing recreational uses such as hunting and fishing. They are also important in providing habitat for terrestrial and aquatic organisms including migratory birds and threatened and endangered plants and animals.

3.6.6.3 Aquatic Resources

Aquatic resources vary greatly between potential DOE sites located in the eastern United States and those located in the western part of the country. In the eastern United States, ample rainfall results in the presence of permanent water bodies varying from small streams to major rivers. Natural and manmade ponds and reservoirs are more prominent on or in the vicinity of eastern sites. Numerous species of aquatic flora and fauna occur at these sites. DOE sites located in the western United States typically experience limited rainfall and therefore, have few aquatic resources. In many cases the only water bodies present are evaporation and waste ponds, although major rivers do occur in the vicinity of some sites. Western sites typically have fewer species of aquatic organisms than eastern sites.

3.6.6.4 Threatened and Endangered Species

Threatened and endangered species could be present at a generic DOE site; however, the species involved would be highly dependent on site location. At present, there are 1,230 federally listed threatened and endangered species in the United States (FWS 2000). States also typically identify threatened and endangered, as well as other special status species, found within their borders. Endangered plants and animals often rely on sensitive environments, such as wetlands, for habitat. Critical habitats, areas that are considered essential to the conservation of a species and that could require special management consideration or protection, can be designated and protected under the Endangered Species Act. Protection of threatened and endangered species and their habitat is important for maintaining biodiversity, which is essential for full ecological function.

3.6.7 Cultural and Paleontological Resources

Cultural and paleontological resources include prehistoric resources, historic resources, Native American resources, and paleontological resources. The presence or absence of such resources at a generic accelerator(s) or research reactor site is highly dependent upon the specific location of the DOE site involved. In accordance with applicable Federal and state laws and regulations, any site selected for the accelerator(s) or research reactor would have to be surveyed before construction could begin. Also, consultation with State Historic Preservation Officers and tribal representatives would be required.

3.6.7.1 Prehistoric Resources

Prehistoric resources in the vicinity of a generic DOE site may include sites, districts, or isolated artifacts. Archaeological sites may represent occupation during the Archaic through later prehistoric periods and can include hunting and butchering sites, cemeteries, campsites, and tool manufacturing areas. They may yield artifacts such as stone tools and associated manufacturing debris, and ceramic potsherds. Some prehistoric sites may be included on the National Register of Historic Places, while others may be eligible for listing.

3.6.7.2 Historic Resources

Historic resources potentially present on a generic DOE site include cemeteries, remains of commercial or residential structures, standing structures, or routes used by settlers during westward expansion. While some of these sites may already be on the National Register of Historic Places, others may be eligible for listing. DOE sites may also contain more recent structures of historic significance including those associated with the Manhattan Project and the Cold War era.

3.6.7.3 Native American Resources

Native American resources can include cemeteries, geological or geographic elements (such as mountains or creeks), certain species of animals or plants, architectural structures (such as pueblos), battlefields, or trails. Such resources are important to Native American groups for religious or historical reasons. Many DOE sites contain Native American resources and some sites have signed agreements with local tribes that designate certain rights to those tribes.

3.6.7.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plant or animals form a former geological age. Paleontological remains consist of fossils and their associated geological information. The presence of such resources at a generic DOE site is dependent upon the past geologic history of the site.

3.6.8 Socioeconomics

The socioeconomic characteristics of a generic DOE site will vary widely depending on whether the site is located near a large urbanized area or in a remote rural area. Statistics for employment and regional economy are defined for the regional economic area. Statistics for population, housing and community services are defined for the region of influence, which include the counties where nearly 90 percent of the DOE site's employees reside. Since the region of influence population for a generic DOE site could range from nearly 2,000,000 people for a site located in a large metropolitan area, to less than 200,000 for a site located in a small rural community, the socioeconomic impacts of the proposed action will vary immensely. The construction and operation of one or two new accelerators or a new research reactor at a generic DOE site are more likely to have an impact on housing and community services in a remote rural community than one located near a large metropolitan area. Likewise, the impacts on the regional economy and employment could also vary widely. Taking the unemployment rate into account, siting the new accelerator(s) or research reactor at a generic DOE site located in a rural area would have more of an impact on the economy than one located near a large metropolitan area.

If DOE were to select an alternative to build one or two new accelerators or a new research reactor, another EIS would be required to select the specific DOE site to locate the facility. In that document, DOE would perform a thorough evaluation of the socioeconomic impacts of the sites under consideration.

3.6.9 Existing Human Health Risk

3.6.9.1 Radiation Exposure and Risk

Major sources and levels of background radiation exposure to individuals in the vicinity of the generic site where the new accelerator(s) and research reactor could be located are shown in **Table 3–35**. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to accelerator(s) or reactor site operations.

Table 3–35 Sources of Radiation Exposure to Individuals in the Vicinity Unrelated to Operation at the Accelerator(s) or Reactor Site

Source	Effective Dose Equivalent (millirem per year)
Natural background radiation	
Cosmic radiation	27 to 48
External terrestrial radiation	28 to 74
Radon in homes (inhaled)	200
Internal terrestrial radiation	40
Other background radiation	
Diagnostic x-rays and nuclear medicine	53
Weapons test fallout	Less than 1
Air travel	1
Consumer and industrial products	10
Total	360 to 427

Note: Value of radon is an average for the United States.
Source: Hamilton et al. 1999; Evans et al. 1998: 4-19.

Releases of radionuclides to the environment from accelerator(s) or reactor site operations provide another source of radiation exposure to individuals in the vicinity of the site. Types and quantities of radionuclides released from accelerator(s) or reactor site operations are listed in the annual radiological effluent release reports for the reference sites. The doses to the public resulting from these releases are presented in **Table 3–36.** (The data provides a range of consequences to the public based on those associated with DOE sites whose offsite consequences are expected to bound those from the accelerator(s) or reactor site.) These doses fall within radiological guidelines and limits (DOE Order 5400.5) and are small in comparison to background radiation.

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public, the latent cancer fatality risk to the maximally exposed member of the public due to radiological releases from operations at the accelerator(s) or reactor site is estimated to range from 1.1×10^{-8} to 2.2×10^{-6} per year. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of accelerator(s) or reactor site operations ranges from about 1 in 90 million to 1 in 450,000. Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.

Based on the same risk estimator, a range of 1.2×10^{-4} to 3.0×10^{-2} excess fatal cancers is projected in the population living within 80 kilometers (50 miles) of the accelerator or reactor site from normal operations. To place these numbers into perspective, they can be compared with the numbers of fatal cancers expected in these populations from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year. Based on this mortality rate, the number of fatal cancers expected from all causes in the population living within 80 kilometers (50 miles) of the accelerator(s) or reactor site

Table 3–36 Radiation Doses to the Public from Normal Operation at the Accelerator(s) or Reactor Site (Committed Effective Dose Equivalent)

Members of the Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual	Standard[a]	Actual[b]	Standard[a]	Actual
Maximally exposed individual (millirem)	10	0.021 to 0.73	4	0 to 2.7	100	0.021 to 4.4[c]
Population within 80 kilometers (person-rem)	None	0.23 to 12.3	None	0 to 48	None	0.23 to 60.3
Average individual within 80 kilometers (millirem)[d]	None	0.0019 to 0.014	None	0 to 0.055	None	0.0019 to 0.069

a. The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10-millirem-per-year limit from airborne emissions is required by the Clean Air Act, and the 4-millirem-per-year limit is required by the Safe Drinking Water Act; for this NI PEIS, the 4-millirem-per-year value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. The total dose of 100 millirem per year is the limit from all pathways combined. The 100-person-rem value for the population is given in proposed 10 CFR Part 834, as published in 58 FR 16268. If the potential total dose exceeds the 100-person-rem value, it is required that the contractor operating the facility notify DOE.
b. These doses are mainly from drinking water and eating fish.
c. This total dose includes a conservative value of 1 millirem per year from direct radiation exposure.
d. Obtained by dividing the population dose by the number of people living within 80 kilometers (50 miles) of the site.
Source: Hamilton et al. 1999; Evans et al. 1998:4-19.

ranged from 243 to 1,760. These numbers of expected fatal cancers are much higher than the estimated range of 1.2×10^{-4} to 0.030 fatal cancers that could result from operations at the accelerator(s) or reactor site.

At the accelerator(s) or reactor site, workers receive the same dose as the general public from background radiation but also receive an additional dose from working at the site. The range of the average worker, maximally exposed worker, and total worker dose from operations at the accelerator(s) or reactor site are presented in **Table 3–37**. These doses fall within radiological regulatory limits (10 CFR Part 20). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers, the number of excess fatal cancers to accelerator(s) or reactor site workers from operations is estimated to range from 0.031 to 0.046 per year (DOE 1999d).

Table 3–37 Annual Doses to Workers from Normal Operation at the Accelerator(s) or Reactor Site (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (millirem)	ALARA[b]	48 to 101
Total workers[c] (person-rem)	ALARA	78 to 115

a. The radiological limit for an individual worker is 5,000 millirem per year. However, DOE's goal is to maintain radiological exposure as low as reasonably achievable. It has therefore established the Administrative Control Level of 2,000 millirem per year; the site must make reasonable attempts to maintain individual worker doses below this level.
b. As low as is reasonably achievable.
c. The number of badged workers ranges from 1,141 to 1,614.
Source: DOE 1999d; 10 CFR Section 835.202.

3.6.9.2 Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact, for example, surface waters during swimming and soil through direct contact or via the food pathway.

Carcinogenic Effects. Health effects in this case are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. This could be incremental or excess individual lifetime cancer risks.

Noncarcinogenic Effects. Health effects in this case are determined by the ratio between the calculated or measured concentration of the chemical in the air and the reference concentration or dose. This ratio is known as the Hazard Quotient. Hazard Quotients for noncarcinogens are summed to obtain the Hazard Index. If the Hazard Index is less than 1, no adverse health effects would be expected.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements, such as air emissions and NPDES permit requirements, contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at the accelerator(s) or reactor site via inhalation of air containing hazardous chemicals released to the atmosphere by site operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure are low, relative to the inhalation pathway.

Exposure pathways for accelerator(s) or reactor site workers during normal operations may include inhaling the workplace atmosphere and direct contact with hazardous material associated with work assignments. Occupational exposure varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. At the accelerator(s) or reactor site, workers are also protected by adherence to OSHA and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals used in the operational processes, ensures that these standards are not exceeded. Worker health conditions at the generic existing accelerator(s) or reactor site are expected to be substantially better than required by the standards.

3.6.9.3 Health Effects Studies

Under Alternatives 3 and 4 of this NI PEIS, DOE would construct one or two accelerators or a research reactor at a generic DOE site for irradiation of targets to produce isotopes or for research. Once the specific sites are identified, DOE would review epidemiologic studies for the specific sites under consideration.

3.6.9.4 Accident History

Accelerators and research reactors have been operating in the United States for many years. Accident information for these accelerators and research reactors, where applicable, can be found in documentation available from DOE and NRC. Estimates of potential accidents and their consequences can also be found in safety analysis reports and probabilistic risk assessments prepared by the accelerator or reactor owners and filed with NRC.

3.6.9.5 Emergency Preparedness

The generic DOE accelerator(s) or reactor site would have a DOE-approved emergency management program that would be activated in the event of an accident. The programs are compatible with other Federal, state, and local plans and are thoroughly coordinated with all interested groups.

3.6.10 Environmental Justice

As discussed in Appendix K, Executive Order 12898 directs Federal agencies to address disproportionately high and adverse health or environmental effects of alternatives on minority and low-income populations. The Executive order does not alter prevailing statutory interpretations under NEPA or existing case law. Regulations prepared by the Council on Environmental Quality remain the foundation for preparing environmental documentation in compliance with NEPA (40 CFR Parts 1500 through 1508) and the Council's guidelines for inclusion of environmental justice under NEPA (CEQ 1997). Specific locations must be designated before detailed reviews of Environmental Justice can be conducted.

3.6.11 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE activities. The waste is managed using appropriate treatment, storage, and disposal technologies and in compliance with all applicable Federal and state statutes and DOE orders.

3.6.11.1 Waste Inventories and Activities

DOE facilities manage the following types of waste: high-level, transuranic, mixed transuranic, low-level radioactive, mixed low-level radioactive, hazardous, and nonhazardous. Although high-level radioactive waste would not be generated by the proposed plutonium-238 production, new medical and industrial isotope production, or new nuclear research and development activities, it is discussed in this section because transuranic wastes that would be generated may be managed as high-level radioactive wastes at DOE facilities.

The volume of high-level radioactive waste currently stored in addition to expected generation for individual DOE sites ranges from 0 to about 213,000 cubic meters (280,000 cubic yards) (DOE 1997a:summary, 71). The volume of transuranic and mixed transuranic waste currently stored and projected through the year 2033 for individual DOE sites ranges from 0 to about 80,000 cubic meters (100,000 cubic yards). These volumes include estimates from environmental restoration, decontamination and decommisssioning, and future Departmental missions, such as the disposition of weapons-usable plutonium at SRS (DOE 1997e:3).

Based on current inventories and 20 year projections, the disposal volume for low-level radioactive waste for individual DOE sites ranges from 0 to about 3.5 million cubic meters (4.6 million cubic yards) and the disposal volume for mixed low-level radioactive waste for individual DOE sites ranges from 0 to about 320,000 cubic meters (420,000 cubic yards). These volumes include waste resulting from waste management operations and environmental restoration activities (DOE 1998k:app. A). Hazardous waste is generated or exists at most DOE facilities. The annual volume for individual DOE sites ranges from 0 to about 640,000 metric tons per year. These volumes include both wastewater and nonwastewater, RCRA-defined waste only (it does not include Toxic Substance Control Act regulated hazardous waste, state-regulated hazardous waste, and environmental restoration-generated hazardous waste) (DOE 1997a:summary, 80).

Waste management and activities specific to each category of waste are discussed in the following sections.

3.6.11.2 High-Level Radioactive Waste

High-level radioactive waste is the highly radioactive waste resulting from processing spent nuclear fuel and irradiated targets from reactors and is liquid before it is treated and solidified. Some of its constituents will remain radioactive for thousands of years. High-level waste is also a mixed waste because it contains hazardous constituents that are regulated under RCRA (DOE 1997a:1-27). Although the proposed plutonium-238 production, new medical and industrial isotope production, or new nuclear research and development activities would not generate high-level radioactive waste, some DOE facilities manage its transuranic waste as high-level waste. The high-level radioactive waste Record of Decision issued on August 12, 1999 (64 FR 46661) states that immobilized high-level radioactive waste will be stored at the DOE site of generation until transfer to a geologic repository.

3.6.11.3 Transuranic and Mixed Transuranic Waste

Transuranic waste is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years and atomic number greater than 92, except for (a) high-level radioactive waste, (b) waste that the Secretary of Energy has determined, with the concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations, or (c) waste that NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61. Transuranic waste is produced during reactor fuel assembly, nuclear weapons production, research and development, and spent nuclear fuel processing. The transuranic waste Record of Decision, issued on January 20, 1998 (63 FR 3629), states that DOE will develop and operate mobile and fixed facilities to characterize and prepare transuranic waste for disposal at WIPP. Each DOE site that has or will generate transuranic waste will, as needed, prepare and store its transuranic waste on site.

3.6.11.4 Low-Level Radioactive Waste

Low-level radioactive waste includes all radioactive wastes that is not classified as high-level radioactive waste, spent nuclear fuel, transuranic waste, uranium and thorium mill tailing, or waste from processed ore. Most low-level radioactive waste consists of relatively large amounts of waste materials contaminated with small amounts of radionuclides, such as contaminated equipment (e.g., gloveboxes, ventilation ducts, shielding, and laboratory equipment), protective clothing, paper, rags, packing material, and solidified sludges. Test specimens of fissionable material irradiated for research and development, only, and not for the production of power or plutonium, may be classified as low-level radioactive waste, provided the concentration of transuranics is less than 100 nanocuries per gram of waste. Low-level radioactive waste is subject to the Atomic Energy Act and is categorized as contact handled or remote handled, and as alpha or nonalpha on the basis of the types and levels of radioactivity present. However, most low-level radioactive waste contains short-lived radionuclides and generally can be handled without additional shielding or remote handling equipment (DOE 1997a:1-24). Currently, DOE sites which manage low-level radioactive waste treat and/or dispose of the waste on site or off site either at another DOE facility or commercial facility. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision issued on February 18, 2000 (65 FR 10061), states that for the management of low-level radioactive waste, minimal treatment will be performed at all sites, and disposal will continue, to the extent practicable, on site at INEEL, LANL, ORR, and SRS. In addition, Hanford and the Nevada Test Site will be available to all DOE sites for low-level radioactive waste disposal.

3.6.11.5 Mixed Low-Level Radioactive Waste

Mixed low-level radioactive waste contains both hazardous and low-level radioactive components. The hazardous component in mixed low-level radioactive waste is subject to RCRA, whereas the radioactive components are subject to the Atomic Energy Act (42 U.S.C. 2011 et seq.). Mixed low-level radioactive waste is characterized as either contact handled or remote handled and as alpha or nonalpha. Mixed low-level radioactive waste results from a variety of activities, including the processing of nuclear materials used in nuclear weapons production, and energy research and development activities. Although there are some commercial and DOE treatment facilities available, commercial and DOE facilities are insufficient to treat DOE's inventory of mixed low-level radioactive waste (DOE 1997a:1-24). Most of DOE's mixed low-level radioactive waste is being stored on site awaiting the development of treatment methods. DOE is subject to the requirements mandated by the Federal Facility Compliance Act of 1992, and most DOE facilities that currently store or generate mixed low-level radioactive waste have either a state-approved or EPA region-approved Site Treatment Plan or another type of agreement. Each Site Treatment Plan or agreement requires treatment of mixed waste, including mixed low-level radioactive waste, in accordance with its provisions.

The low-level radioactive waste and mixed low-level radioactive waste Record of Decision, issued on February 18, 2000 (65 FR 10061), states that mixed low-level radioactive waste will be treated at Hanford, INEEL, ORR, and SRS and disposed of at Hanford and the Nevada Test Site.

3.6.11.6 Hazardous Waste

The quantities and types of hazardous waste generated as a result of DOE activities vary considerably and include acids, metals, industrial solvents, paints, oils, rags contaminated with hazardous cleaning compounds, and other hazardous materials that are byproducts of routine maintenance and operations. About 99 percent of DOE's hazardous waste is wastewater and is treated at DOE sites. Treatment residues and the remaining 1 percent, predominantly solvents and cleaning agents, are treated at commercial facilities. The hazardous waste Record of Decision, issued on August 5, 1998 (63 FR 41810), states that most DOE sites will continue to use offsite facilities for treatment and disposal of major portions of the nonwastewater hazardous waste, with ORR and SRS continuing to treat some of their own nonwastewater hazardous waste on site in existing facilities, where this is economically favorable.

3.6.11.7 Nonhazardous Waste

Nonhazardous and nonradioactive sanitary and industrial waste requires limited handling and can be treated or disposed in properly designed facilities or used in energy production. DOE currently manages sanitary and industrial waste on a site-by-site basis. Some DOE sites dispose of this waste in onsite landfills that have permits issued by appropriate State agencies, while other sites use commercial landfills (DOE 1997a:1-29).

3.6.11.8 Waste Minimization

The DOE complex-wide waste reduction goals for achievement by December 31, 1999 (compared to the 1993 Baseline) are to reduce low-level radioactive waste, mixed low-level radioactive waste, and hazardous waste generation by 50 percent, and nonhazardous waste by 33 percent (DOE 1999f:1).

3.6.12 Spent Nuclear Fuel

The operation of the new reactor will generate nuclear spent fuel at a rate of about 0.31 metric tons of heavy metal per year (Appendix E of this NI PEIS). The Nuclear Waste Policy Act of 1982, as amended, assigned the Secretary of Energy the responsibility for the development of a repository for the disposal of high-level radioactive waste and spent nuclear fuel. When such a repository is available, spent nuclear fuel would be transferred for disposal from the nuclear reactor site to the repository. Until a repository is available, spent nuclear fuel generated from the operation of the new reactor is expected to be stored on site in the reactor spent fuel pool, which provides the capacity for spent fuel generated from 35 years of operation.

3.7 REFERENCES

Code of Federal Regulations

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10 CFR Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," U.S. Nuclear Regulatory Commission.

10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," U.S. Nuclear Regulatory Commission.

10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," U.S. Nuclear Regulatory Commission.

10 CFR Part 834, "Radiation Protection of the Public and Environment, Proposed Rule," March 25, 1993, U.S. Department of Energy.

10 CFR Part 835, "Occupational Radiation Protection," U.S. Department of Energy.

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14 CFR Part 150, "Airport Noise Compatibility Planning," Federal Aviation Administration, U.S. Department of Transportation.

33 CFR Section 328.3, "Navigation and Navigable Waters," Definition of Waters of the United States, Definitions, U.S. Corps of Engineers.

40 CFR Part 50, "National Primary and Secondary Ambient Air Quality Standards," U.S. Environmental Protection Agency.

40 CFR Part 70, "State Operating Permit Programs," U.S. Environmental Protection Agency.

40 CFR Section 81.313, "Designation of Areas for Air Quality Planning Purposes, Idaho," U.S. Environmental Protection Agency.

40 CFR Section 81.343, "Designation of Areas for Air Quality Planning Purposes, Tennessee," U.S. Environmental Protection Agency.

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